Environment Canada Environnement Canada

Canada - Ontario Agreement on Great Lakes Water Quality

Ontario Ministry of the Environment

ENVIRONMENTAL BASELINE REPORT OF THE NIAGARA RIVER

NOVEMBER 1981 UPDATE

CANADA-ONTARIO REVIEW BOARD

NOVEMBER 16, 1981

November 16, 1981

TABLE OF CONTENTS

	Page
SUMMARY AND CONCLUSIONS	3
A. BACKGROUND	9
B. CONDITION OF THE NIAGARA RIVER - UPDATE	10
1. Data Sources	10
(a) Environment Canada (Water Quality Branch)	10
(b) Environment Canada (Canadian Wildlife Service)	10
(c) Ontario Ministry of the Environment (Water Resources Branch)	11
(d) Ontario Ministry of the Environment (West-Central Region)	11
2. Water	11
(a) Lower Niagara River	12
(i) Trace Metals	12
(ii) Organics	13
(b) Upper Niagara River	14
(i) Trace Metals	14
(ii) Organics	14
3. Suspended Sediments	16
(i) Trace Metals	16
(ii) Organics - Routine Parameters	16
(iii) Organics - Non-Routine Parameters	17
4. Bottom Sediments	18
5. Biota	19
(a) Freshwater Clams and Cladophora Studies	19
(b) Fish	20
(c) Herring Gull Eggs	23

TABLE OF CONTENTS - CONTINUED

		Page
6.	Municipal Water Supplies	24
	(a) Raw Water	24
	(b) Treated Water	25
C.	INPUTS (INDUSTRIAL AND MUNICIPAL)	27
1.	Background	27
2.	Trace Contaminants Loadings	28
D.	RESPONSE TO IJC SPECIAL REPORT ON POLLUTION IN THE NIAGARA RIVER, January 20, 1981	30

RAPPORT ENVIRONNEMENTAL SUR LE NIAGARA

- Mise à jour, novembre 1981

Commission d'étude Canada - Ontario

RÉSUMÉ ET CONCLUSIONS

En juin 1980, la Commission d'étude Canada-Ontario a publié son rapport environnemental sur le Niagara (Environmental Baseline Report on the Niagara River). Ce rapport concernait les problèmes de qualité de l'eau dus à une insuffisance de contrôle des déversements de substances toxiques, mis en évidence par la présence de ces substances dans le Niagara et dans le Lac Ontario. Depuis la publication du rapport, on a effectué d'autres analyses sur les études de 1979 et de 1980 et on dispose en outre des premiers résultats d'études plus récentes de 1981. Ces données supplémentaires sont exposées dans le présent rapport de la Commission d'étude Canada-Ontario. Dans le résumé, nous montrons que les résultats et les conclusions du rapport de 1981 sont encore plus nets que ceux du rapport de 1980.

Comparaison avec les objectifs de qualité de l'eau ou de l'environnement actuels

En général, les données relatives à la qualité de l'eau corroborent les résultats du rapport de juin 1980. En moyenne, la qualité de l'eau du Niagara, entre 1975 et 1980, respectait les objectifs de l'accord Canada-États-Unis de 1978 relatif à la qualité des eaux des Grands Lacs. Les objectifs de concentration de certains composés organiques et de certains métaux n'étaient dépassés que pour moins de 10% des échantillons analysés. La plupart des composés organiques étaient indécelables dans l'eau. Quant aux métaux lourds, seuls le fer et le cuivre présentaient fréquemment des concentrations systématiquement supérieures aux objectifs au cours de cette période. Pour beaucoup des substances mesurées, en particulier le fer, le manganèse, le zinc et le mercure, les concentrations étaient systématiquement plus élevées du côté américain dans le cours supérieur du Niagara. Dans le cours inférieur du Niagara, la distribution des polluants était uniforme sur toute la largeur du fleuve, en raison du mélange latéral intense se produisant des chutes aux canaux de fuite des usines hydro-électriques. L'eau de boisson des agglomérations de Niagara-on-the-Lake, Niagara Falls (Canada) et Fort-Érié était conforme aux objectifs de qualité actuels et proposés du Canada et de l'Ontario. Pour plusieurs composés organiques non prévus dans les objectifs actuels de qualité de l'eau potable, les concentrations restaient en deçà des limites recommandées.

Les concentrations de PCB et de α-BHC dans les échantillons de baveux pêchés en 1980 à Niagara-on-the-Lake étaient supérieures à celles mesurées en 1979, bien que ne dépassant pas celles observées en 1978. La Commission d'étude attend les résultats des analyses d'échantillons de 1981 avant de se prononcer sur l'importance de ces mesures du point de vue de la tendance à la baisse observée depuis 1975. Certaines tailles de saumons coho et d'anguilles d'Amérique pris en 1980 dans le cours inférieur du Niagara ne pouvaient être que "consommées occasionnellement" en raison des concentrations de PCB et de mirex dépassant les recommandations de la Direction canadienne de la protection de la santé. D'après certaines projections effectuées par ordinateur, les catostomes noirs de grandes tailles des cours supérieur et inférieur du Niagara contiendraient des niveaux de mercure supérieurs aux recommandations. Environnement Ontario n'a pas détecté de 2, 3, 7, 8 -TCDD (dioxine) dans les filets d'espèces de poissons des cours supérieur et inférieur du fleuve. Toutefois, selon des données obtenues récemment sur deux échantillons par les services américains de la pêche et de la faune (U.S. Fish and Wildlife), il semble que les poissons entiers comporteraient des niveaux décelables de dioxine. Du point de vue des concentrations de PCB, de mirex et de mercure, les perchaudes pêchées dans les parties supérieure et inférieure du fleuve se situent dans les limites recommandées.

Composés précédemment non identifiés et non décelés dans les sédiments en suspension et dans les poissons

Les analyses des sédiments en suspension prélevés dans le Niagara à Niagara-on-the-Lake révèlent un certain nombre de pics précédemment non décelés, correspondant à des composés organiques halogénés jusqu'à présent non identifiés. La détection de ces pics a été rendue possible par la CG/SM* utilisant une colonne capillaire, au lieu d'une colonne chargée. Au moins 21 des pics décelés dans les sédiments en suspension ont également été décelés dans des poissons du Niagara (baveux). Par contre, on n'a retrouvé aucun de ces pics dans les poissons pris en d'autres points du Lac Ontario.

*CG/SM = chromatographie en phase gazeuse/spectométrie de masse

Sources industrielles et municipales

Selon une analyse préliminaire des données obtenues lors d'une enquête portant sur 19 points de déversements d'effluents industriels et municipaux dans le Niagara ou ses affluents, les sources ontariennes représentent en général moins de 1% des apports estimatifs dans le fleuve de métaux-traces et de composés organiques-traces (12 points de déversements ont été sélectionnés pour échantillonnages suivis en 1981).

L'importance des sources ponctuelles et diffuses varie selon le côté du Niagara considéré. Du côté américain, 12 usines municipales de traitement des eaux usées et 89 installations industrielles ont officiellement l'autorisation de l'Etat de New York de déverser leurs effluents dans le Niagara ou dans ses affluents immédiats. Un grand nombre d'autres exploitations industrielles (312) déversent indirectement leurs effluents dans le fleuve par l'intermédiaire des usines municipales de traitement des eaux usées, ce qui leur évite d'avoir à obtenir un permis. On ne dispose pour le moment que de très peu de données sur les rejets de polluants-traces depuis le territoire de l'État de New York. Toutefois, selon les données otenues pour l'usine de traitement des eaux usées de la ville de Niagara Falls (New York), il apparaît que cette usine déverse plus de composés organiques-traces dans le Niagara que toutes les sources ontariennes combinées.

En mai 1981, l'agence américaine pour la protection de l'environnement (U.S.E.P.A.) a effectué une enquête sur 10 points de déversements municipaux et industriels qu'elle soupçonnait de contribuer de façon importante à l'apport de métaux lourds ou de composés organiques. Lorsque les résultats de cette enquête seront disponibles, ils permettront de mieux préciser le tableau des sources de polluants. Dans un rapport de 1979*, l'État de New York identifiait 215 décharges de résidus chimiques (sources diffuses) dans la région des comtés de Niagara et d'Érié. On en connaît au moins 4 qui ont laissé fuir des polluants dans le fleuve (secteurs de Love Canal, de Hyde Park, de 102nd Street, de Hooker "S") et qui sont classées première urgence. À titre de comparaison, le côté ontarien du fleuve comporte trois points de déversements municipaux, 12 points de déversements industriels et 12 terrains de décharge d'effluents municipaux et industriels. La quantité totale d'effluents déversés dans le Niagara par l'ensemble des sources ponctuelles américaines (1499 x $10^3 m^3$ par jour) est plus de 6 fois supérieure à celle provenant de toutes les sources canadiennes (236 x $10^3 m^3$ par jour).

*New York Interagency Task Force on Hazardous Wastes. Rapport préliminaire, mars 1979.

Effets sur le Lac Ontario

Le Niagara est le plus gros tributaire du Lac Ontario. Dans certains cas, on peut lier directement l'état du lac à celui du Niagara, qui constitue la source de polluants unique ou dominante. À cet égard, la contamination des poissons du Lac Ontario par le mirex et la dioxine est révélatrice.

On a identifié le Niagara (et plus particulièrement les rejets américains dans le fleuve) comme la source principale du mirex parvenant au Lac Ontario. En raison de la présence de ce composé dans plusieurs espèces de poissons de pêche sportive du Lac Ontario, le Canada et les États-Unis ont dû procéder à des mises en garde et le service de protection de l'environnement de l'État de New York a interdit totalement la possession de plusieurs espèces. À cause de la contamination par le mirex, plusieurs espèces de poissons du cours inférieur du Niagara ne peuvent être que "consommés occasionnellement". Au moment du rapport de juin 1980, on n'avait pas trouvé de niveaux décelables d'isomères du TCDD (tétra-chloro-dibenzo-dioxines) dans les oeufs de goélands argentés du Niagara. En décembre 1980, Environnement Canada publiait des données plus récentes, signalant la détection de dioxine (2, 3, 7, 8-TCDD) dans les oeufs de goélands argentés des lacs Ontario et Michigan. Les données indiquaient une diminution des concentrations dans le Lac Ontario depuis 1971. La dioxine avait également été décelée par Environnement Ontario dans certains échantillons de poissons de pêche sportive du Lac Ontario, bien que les niveaux soient habituellement inférieurs à la limite de 20×10^{-6} ppm fixée pour la consommation humaine. Dans le cas du Lac Ontario, on soupçonne encore que la source de dioxine dans le Niagara est américaine.

En résumé, les efforts de surveillance du Niagara par les Canadiens montrent que le fleuve est une source continuelle de nombreux métaux-traces et de composés organiques-traces pour le Lac Ontario, en raison du déversement de ces substances dans le Niagara lui-même. En général, moins de 1% des rejets de ces substances dans le fleuve est attribuable à des sources canadiennes. Lorsque l'on procède à des mesures transversales dans le fleuve, on constate que, vers l'amont, les concentrations sont généralement plus élevées du côté américain. Cela est particulièrement notable dans le cours supérieur du Niagara, dans le chenal de Tonawanda. Pour le moment, on ne dispose pas en général de données scientifiques suffisantes pour estimer l'effet sur la santé d'une exposition à long terme à ces composés. Toutefois, dans le cas de la

dioxine et du mirex, les données disponibles montrent que le Niagara, en tant que source de ces composés, a déjà eu un effet certain sur le Lac Ontario en contaminant les colonies de goélands argentés et les poissons. La pêche commerciale de certaines espèces de poissons du Lac Ontario est, dans certains secteurs du lac, interdite en raison des concentrations excessives de mirex. Les mesures montrent une migration des polluants à travers la frontière.

SUMMARY AND CONCLUSIONS

In June, 1980, the Canada-Ontario Review Board released the Environmental Baseline Report of the Niagara River. The report focussed on water quality problems resulting from inadequate control of toxic substances as evidenced by their presence in the Niagara River and Lake Ontario. Since publication of that report, additional analyses on 1979 and 1980 studies have been completed and the preliminary results of more recent (1981) studies have become available. This additional information is presented in the present report of the Canada-Ontario Review Board. This summary highlights the more significant findings and conclusions of the 1981 update relative to the June, 1980 findings.

Comparison with Available Environmental or Water Quality Objectives

In general, water quality data in this report corroborate the findings reported in June, 1980. Yearly average water quality conditions in the Niagara River over the period 1975-1980 met the 1978 Canada-U.S. Great Lakes Water Quality Agreement water quality objectives. Concentrations of some organics and metals exceeded these objectives in less than 10% of the samples analyzed. The concentrations of most organics were non-detectable in water, and for heavy metals, only iron and copper concentrations were frequently noted to exceed the objectives on a consistent basis over this period. Concentrations of many parameters including iron, manganese, zinc and mercury were consistently higher on the U.S. side of the upper river. Distribution of contaminants was uniform across the lower Niagara River, due to strong lateral mixing in the section from the falls to the power plant tailraces. Water supplies serving Niagara-on-the-Lake, Niagara Falls (Canada) and Fort Erie met existing and proposed Canadian and Ontario objectives for drinking water. These supplies also compared favourably with suggested limits for several other organics not presently dealt with in the existing drinking water objectives.

Sediment and Suspended Sediment

Although concentrations of most organics in Niagara River water were below the analytical detection limit, analyses of suspended sediment, bottom sediment and fish indicated the presence of numerous organic compounds in the Niagara River system. Specifically all bottom sediment samples from the lower Niagara River and the majority of samples from the Buffalo River and Tonawanda Channel areas of the upper Niagara River had concentrations of PCBs exceeding 50 ppb - the MOE criterion for confined disposal of dredged spoils. The major portion of the loading of PCBs and some pesticides occurs adjacent to and downstream from Grand Island, New York. The Love Canal and Buffalo River areas are also sources of numerous organics to the river. The estimated annual loading of suspended-sediment associated PCBs to Lake Ontario (based on data collected at Niagara-on-the-Lake in 1979) is approximately 530 kg/yr. A large percentage of bottom sediment samples from the slower moving sections of the lower Niagara exceeded the MOE dredge spoil criteria for a number of trace metals indicating that the river section downstream of Queenston is an accumulation area for contaminated sediments.

Comparison of analyses of suspended sediments from Niagara-on-the-Lake with those taken at a control station at Thunder Bay in Lake Erie indicate that many of the compounds detected in the lower Niagara River are not detectable in Lake Erie. This indicates that there are continuing intermittent inputs of these compounds to the river itself.

Fish

Parent DDT constituted a higher percentage of the total DDT (and metabolites) in spottail shiner fish taken from Niagara-on-the-Lake than those caught in other areas of the river. This parallels an increase in the concentration of parent compound DDT in suspended sediments collected in the same area. The reason for this increase is unknown since DDT has been restricted to use by permit only in Ontario since 1969 and only in medical emergencies in New York State. The possible sources of this pesticide are under further investigation.

PCB and α-BHC concentrations in 1980 spottail shiner samples collected at Niagara-on-the-Lake were higher than those from 1979 although not higher than those observed in 1978. The Review Board is awaiting the results of the 1981 samples before commenting on the significance of these concentrations with respect to the downward trend observed since 1975. Various size ranges of coho salmon, and American eel caught in 1980 in the Lower Niagara River were fit for only "occasional consumption" due to levels of PCBs and mirex exceeding the Canadian human health protection guidelines. Larger sizes of white sucker from both the upper and lower Niagara River, although not captured, were computer-projected to contain mercury levels above the guidelines. 2, 3, 7, 8 -TCDD (dioxin) was not detected by Environment Ontario in fillets of several species of fish from the upper and lower sections of the river. However, recent U.S. Fish and Wildlife data on two samples indicates detectable levels of this compound in whole fish. Yellow perch from both the upper and lower parts of the river were within the guidelines for PCBs, mirex and mercury.

Previously Unidentified and Undetected Compounds in Suspended Sediments and Fish

A number of previously undetected peaks representing as-yet unidentified halogenated organic compounds were observed in the analyses of suspended sediment samples collected from the Niagara River at Niagara-on-the-Lake. Detection of these peaks has been possible because of the use of capillary column GC/MS* instead of packed-column GC/MS. At least 21 of the peaks detected in suspended sediment were also detected in Niagara River fish (spottail shiners). In contrast, these peaks were not detected in fish caught from other locations in Lake Ontario.

*GC/MC = gas chromatography/mass spectrometry.

Industrial and Municipal Sources

Preliminary analysis of the data from a survey of 19 industrial and municipal discharges entering the Niagara River or tributaries to the river indicated that Ontario sources contribute generally less than 1% of the estimated trace metals and organics loadings to the river. (Twelve discharges have been selected for follow-up sampling in 1981.)

The magnitude of point and non-point sources differs on the two sides of the Niagara River. On the U.S. side, 12 municipal wastewater treatment plants and 89 industrial facilities are reportedly licenced by New York State to discharge their effluent to the Niagara River (or its immediate tributaries). Numerous (~312) other industrial operations discharge indirectly to the river via municipal wastewater treatment plants, eliminating the need for individual permit requirements. Very little data are as yet available on trace contaminant inputs from the New York State shoreline. However, loading information for the City of Niagara Falls, N.Y. sewage treatment plant indicates it to be a larger contributor to the trace organics load in the Niagara River than all Ontario point sources combined.

Results of a U.S.E.P.A. May 1981, survey of 10 municipal and industrial discharges suspected of being major contributors of heavy metals and/or organics, when available, should better define the loading picture. A 1979 New York State report* identified 215 chemical waste dumps (non-point sources) in the Niagara/Erie county area. Of these, at least four are known to have leaked contaminants into the river (Love Canal, Hyde Park, 102nd Street, Hooker "S" Area) and were rated as priority I. In contrast to New York State, there are 3 municipal and 12 industrial discharges and 12 municipal and industrial waste disposal sites on the Ontario side of the river. Total effluent flow from all U.S. point sources to the Niagara River, at 1499 x 10^3 m^3 per day, is over six times that from all Canadian sources (236 x10^3 m^3 per day).

*New York Interagency Task Force on Hazardous Wastes Draft Report, March 1979.

Effects on Lake Ontario

The Niagara River is the single largest tributary source to Lake Ontario. In some cases, conditions in the lake can be directly related to the Niagara River as the predominant or single point source input. Contamination of Lake Ontario fish by mirex and dioxin illustrate the point.

The Niagara River (specifically U.S. sources to the river) has been identified as the major source of mirex to Lake Ontario. Concentrations of this compound in several species of Lake Ontario sports fish resulted in health advisories on both the Canadian and U.S. side and a total ban on possession of several species being issued by NYDEC. Several species of fish caught in the lower Niagara River are still only suitable for "occasional consumption" due to mirex contamination. The June, 1980 report indicated that no detectable levels of any TCDD (tetrachlorodibenzodioxins) isomers were observed in herring gull eggs from the Niagara River. In December 1980, Environment Canada published more recent data identifying the detection of dioxin (2,3,7,8 - TCDD) in herring gull eggs taken from Lake Ontario (and Lake Michigan). The data indicated a decline in levels in Lake Ontario since 1971. Dioxin has also been detected by Environment Ontario in some Lake Ontario sports fish samples, albeit at levels below the human consumption limit of 20 ppt in most samples. In the case of Lake Ontario, a U.S. source of dioxin in the Niagara River is again suspected.

In summary, the results of Canadian surveillance efforts on the Niagara River indicate that the river is a continuous source of numerous trace metals and organic compounds to Lake Ontario because of inputs of these substances to the Niagara River itself. Generally, less than 1% of the loadings of these substances to the River can be accounted for from Canadian sources. Where cross river measurements have been made, they indicate that concentrations are generally higher on the U.S. side of the upper river. This is most noticeable in the upper Niagara River, in the Tonawanda Channel. There is at present a scarcity of scientific data on the human health significance of long-term exposure to many of these

compounds. However, in the case of both dioxin and mirex, the data indicate that the Niagara River as a source of these compounds has impacted Lake Ontario through the contamination of herring gull colonies and the fishery. Certain species of fish from specific areas of Lake Ontario are banned for commercial fishing because of mirex and PCBs levels. These impacts indicate transboundary movement of pollutants.

A. BACKGROUND

In recent years, concern has developed over the recurring detection of persistent toxic substances in the Great Lakes Basin and their varied and uncertain effects on the ecosystem. Accordingly, the 1978 Agreement on Great Lakes Water Quality between Canada and the United States, which contains many new water quality objectives for protecting "the recognized most sensitive use in all waters", also provides for coordinated programs and measures for the control of toxic substances.

In this regard, problems associated with major waste disposal sites, both old and new, and proposals for additional waste discharges to the Niagara River from New York State have become issues of increasing public concern. This concern developed during a period when significant progress in the control of municipal and industrial pollution had been made, following the 1972 Agreement on Great Lakes Water Quality. Nevertheless, water quality problems due to bacterial and phenol contaminants were reported to persist by the IJC (IJC-Great Lakes Water Quality, 1978 Annual Report) because corrective programs for both municipalities and industry initiated since the 1972 Agreement are yet to be completed.

To assess progress and increase understanding of the complex water quality problems associated with persistent toxic substances, Canada and Ontario have conducted intensive surveillance and monitoring of the Niagara River in recent years. Measurements of a wide range of parameters in water, sediments, suspended sediments, fish, herring gull eggs and other biota, have been made jointly by the federal and provincial governments in consultation with U.S. federal and state authorities. In June 1980, the Review Board of the Canada/Ontario Agreement on Great Lakes Water Quality released the "Environmental Baseline Report on the Niagara River" which focussed on water quality problems resulting from inadequate control of toxic substances as evidenced by their presence in the Niagara River and Lake Ontario. Since the publication of that report, additional analyses have been completed and the results of more recently implemented studies have become

available. This report summarizes this additional information and provides an update on the conditions and status of programs addressing water quality problems in the Niagara River.

B. CONDITION OF THE NIAGARA RIVER - UPDATE

1. Data Sources

Since publication by the COA Review Board of its "Environmental Baseline Report of the Niagara River" in June 1980, considerable additional information has become available as a result of completed analyses of past programs and new initiatives by both federal and provincial agencies. This additional available information includes:

(a) Environment Canada (Water Quality Branch)

(i) the completed 1979 data set plus 1980 data for trace metals analyses in water samples collected at a fixed station in the lower Niagara River adjacent to Niagara-on-the-Lake;

(ii) 1980 data on organics in water samples collected at the above station;

(iii) the completed 1979 data set for water samples (trace metals and organics) collected in the upper Niagara River;

(iv) completed 1978-1980 data on trace metals and organics in suspended sediment samples collected at Niagara-on-the-Lake; and

(v) data on "non-routine" identification of organics in suspended sediment and comparison of results with fish caught in the Niagara River and other locations in Lake Ontario (in cooperation with the Ministry of Natural Resources, Ministry of the Environment and Fisheries and Oceans Canada).

(b) Environment Canada (Canadian Wildlife Service)

(i) update on 2,3,7,8 - TCDD analyses in Lake Ontario herring gulls eggs;

(c) Ontario Ministry of the Environment (Water Resources Branch)

(i) additional data from the 1979 Trace Contaminants Survey of the upper and lower sections of the Niagara River including chlorophenoxy acid herbicide, chlorophenols, and gas chromotography/mass spectrometry analyses and further evaluation of PCBs, heavy metals and organochlorine pesticides data;

(ii) completed data on trace contaminants (metals, PCBs, organochlorine pesticides, phenols) in water samples collected during 1980 in the upper and lower sections of the Niagara River;

(iii) results of trace contaminants analyses of biota including forage fish (spottail shiners), adult sport fish, freshwater clams and algae (Cladophora);

(d) Ontario Ministry of the Environment (West-Central Region)

(i) completed 1979 and 1980 data sets on PCBs, organochlorine pesticides, volatile organics, dioxin and radionuclides in raw and treated water samples collected at Ontario Water Treatment Plants drawing water from The Niagara River;

(ii) results of a preliminary 1981 trace contaminants survey of Ontario municipal and industrial discharges entering the Niagara River system.

2. Water*

Water quality discussed in this section is compared to the water quality objectives of the 1978 Canada/United States Great Lakes Water Quality Agreement and the Environment Ontario publication "Water Management" (1978) formulated for the protection of aquatic life.*

---

* Drinking Water Quality is discussed in Section 6.0

(a) Lower Niagara River

(i) Trace Metals

Since 1975, Environment Canada (DOE) has collected weekly water samples for trace metal analyses at a station in the river adjacent to Niagara-on-the Lake (Figure 1). Data indicating the mean annual concentrations of these metals and the percentage of samples exceeding the water quality objectives for the period 1975-1980 are summarized in Tables 1 and 2 respectively. The 1980 data can be compared to those collected by Environment Ontario (MOE) along river range 1.3 (Figure 1) as part of four 3-day Water Quality and Trace Contaminants Surveys of the Niagara River during 1980 (Table 3). The most significant feature of these data is that iron and copper are the only two trace metals which have consistently exceeded the objectives over the last five years. The percent of violations for iron ranged from 15-14%; the range for copper was 7-79%. Exceedences were observed for a smaller percentage of samples of other metals such as cadmium (0-7%), chromium (0-2%), nickel (0-2%). In contrast to federal (DOE) data, which indicated 0% exceedences for filtered mercury, 13% of samples collected by MOE during 1980 exceeded the objective for this metal. Furthermore, in contrast to the 1979 data in which the mean annual concentrations for both copper and iron were observed to exceed the objectives, Environment Canada data for 1980 indicate that only iron exceeded the objective. The 1980 Environment Ontario results indicate a mean value for iron which does not exceed the objective. The difference between the 1980 DOE and MOE data may well be explained by the normal high variation observed in the concentrations of this metal in the river water and the fact that samples were collected on different days. This is illustrated in Figure 2 which shows substantial weekly variations in iron concentrations, probably related to a number of factors, among them being natural climatic events such as heavy rainfall and high winds which stir up bottom sediment and cause surface run-off.

(ii) Organics

During 1980, Environment Canada collected water samples at Niagara-on-the Lake for organic contaminant analyses. The available data to September, 1980 as well as the percent of confirmed detections, are summarized in Table 4. These may also be compared to data collected by Environment Ontario along river range 1.3 as part of the 1980 Water Quality Surveys (Table 3). Additional data on PCBs, organochlorine pesticides, volatile organics and dioxin in lower Niagara River water is discussed in Section 6.0 - "Municipal Water Supplies" under "Raw Water".

Briefly, the data indicate that the concentrations of most compounds were non-dectectable at their respective detection limits, which themselves are, in most cases, well below the water quality objective values. PCBs (total), dieldrin, α-BHC, γ-BHC (lindane) and HCB were the only compounds detected in greater than 50% of the samples analyzed. Environment Ontario data indicate that mean concentrations of PCBs and organochlorine pesticides met available Agreement objectives. However, concentrations of aldrin/dieldrin, total DDT + metabolites, endrin, heptachlor/heptachlor expoxide and endosulphan (Thiodan) occasionally ($< 10\%$ of samples) exceeded objectives. Phenols exceeded the objectives in 25% of the samples. In contrast, Environment Canada data indicated that only lindane exceeded the objective (on one occasion only).

During the 1979 MOE Trace Contaminants Survey, pentachlorophenol was only detected in water samples taken from the lower Niagara River. Detectable concentrations were observed in four out of nine samples collected from both the Canadian and U.S. sides of the river. Concentrations ranged from 0.01 μg/L to 8.5 μg/L, but only one sample exceeded the proposed Agreement objective for pentachlorophenol of 0.4 μg/L. Concentrations of other chlorophenols including 2,3,4-, 2,4,5-, and 2,4,6- trichlorophenol were below analytical detection limits at other stations sampled in the river. No chlorophenoxy acid herbicides (2,4-D; 2,4,5-T; 2,4-DB; Silvex) were detected in water samples.

(b) Upper Niagara River

(i) Trace Metals

Eleven single day surveys along six river ranges were conducted by Environment Canada in the upper Niagara River (Figure 1) during 1979 at approximately three week intervals. Trace metals and organics were sampled on alternate surveys. Results are summarized in Tables 5 and 6. Briefly, the data indicate little change from preliminary data reported in the June, 1980 report of the Board. With the exception of iron, trace metal concentrations exceeded the water quality objectives in less than 10% of the samples. Mean values for iron exceeded the objective at all river ranges except range 26.7 at the mouth of the Chippawa Channel. Figure 3 represents a three dimensional plot of total iron concentrations in the two channels of the upper Niagara River in 1979. Cross-stream and downstream increases were observed in the Tonawanda Channel while only small variations were detected in the Chippawa Channel. Concentrations were generally higher on the U.S. side of the river. Similar distributions were observed for total manganese and zinc.

Trace metal data collected on four occasions by MOE during 1980 are summarized in Table 3. Briefly, they generally agree with the 1979 findings discussed above. With the exception of iron (22-23% exceedence of objective in both channels) and mercury (18% exceedences in Tonawanda Channel) 10% or less of the samples exceeded the objectives for cadmium, chromium, copper and zinc. Mean concentrations of many of the parameters were higher in the upper part than in the lower part of the river. In the upper river, they were higher on the U.S. side (eg. Tonawanda Channel). This is illustrated for iron and mercury in Figures 4 and 5 respectively.

(ii) Organics

1979 Environment Canada data for organic contaminants are summarized in Table 7 in decreasing order of the number of confirmed detections. These data represent a total of 72 water samples collected -

12 per range on six different surveys. While compounds such as α-BHC, and γ-BHC (Lindane) were detected frequently, only phenols exceeded the 1978 Agreement objective (4% of the time). It should also be noted that the mean concentration of PCBs (0.005 μg/l) exceeded the MOE objective (0.001 μg/l).

Environment Ontario data collected during four surveys in 1980 along river ranges 19.3 and 20.5 are summarized in Table 3. Although mean concentrations of PCBs and organochlorine pesticides did not exceed available Agreement objectives, concentrations of PCBs, aldrin/dieldrin, total DDT + metabolites and endrin exceeded the water quality objectives in from 2-21% of the samples of these compounds. Aldrin/dieldrin and heptachlor/heptachlor epoxide had a higher percentage of exceedeness in Chippawa Channel samples, while PCBs and endrin had a slightly greater percentage of exceedences in Tonawanda Channel samples. A high percentage of samples from both channels (64-67%) contained detectable concentrations of α-BHC. The concentration of phenol exceeded the objective in 10% of the samples from the Tonawanda Channel and 8% of samples from the Chippawa Channel.

In general, these additional data on water quality substantiate the observation of the Board's June 1980 report that "while some of the objectives for the protection of aquatic life were occasionally exceeded...the average yearly water quality conditions met the objectives". Only iron and copper were found to consistently exceed the objectives, with the remainder of the metals and organics samples exceeding the objectives generally less than 10% of the time. Indeed, the concentrations for most organic compounds were non-detectable at their respective detection limits in water.

There is considerable temporal and spatial variability in the concentrations of many of these parameters in the river system throughout the year. Generally, water quality conditions in the upper Niagara River are better than those in the lower River. In the upper Niagara River, water quality conditions were better in the Chippawa Channel than in the Tonawanda Channel.

Additional data on PCBs, organchlorine pesticides, volatile organics and dioxin in upper Niagara River waters is discussed in Section 6.0 "Municipal Water Supplies" under "Raw Water".

3. Suspended Sediments

Suspended sediment samples for trace metals and organics analyses have been collected by Environment Canada at Niagara-on-the-Lake since 1978.

(i) Trace Metals

Since the June 1980 report, trace metal analyses have been completed on some 1978 and 1979-80 suspended sediment samples. Results have been summarized in Table 8. Time/concentration plots for each parameter (cadmium, cobalt, lead, chromium, copper, nickel and zinc) are presented in Figures 6 through 9. As with concentrations of these substances in water, it is clearly evident that their concentrations in suspended sediment are also quite variable throughout the year. No seasonal trend is evident. Although there are no 1978 Canada/U.S. Agreement objectives for metals in suspended sediment, the concentrations of these metals do exceed the MOE criteria for open water disposal of dredged spoils (bottom sediments) most of the time.

(ii) Organics - Routine Parameters

A summary of the data available from January 5 - August 19, 1980 on organic contaminants in suspended sediment is provided in Table 9. The data indicate quantifiable levels of total PCBs, dieldrin, mirex, α-BHC, HCB, p,p'-DDE, γ-chlordane and methoxychlor as well as numerous other compounds. No 1978 Agreement objectives exist for contaminant concentrations of PCB in natural sediment, but the MOE dredge spoils criterion is 50 ppb. Concentrations of PCB in Niagara River suspended sediment exceeded this criterion in 100% of the samples taken during 1980.

Time/concentration plots of total PCBs, mirex, and total chlorobenzene isomers are presented in Figures 10 through 12. The similarity between the total chlorobenzene isomers and PCBs in their temporal trends during 1980 suggests possibly similar sources for these two classes of compounds. Of particular interest are large increases of p,p'-DDT in the suspended sediments collected at Niagara-on-the-Lake since May, 1980. It should be emphasized that this is fresh DDT, which seems to have appeared suddenly, not a degradation product. The reason for this sudden occurrence of fresh parent compound DDT is at present inexplicable since in 1969, provisions of Ontario's Pesticides Control Act limited the use of this pesticide to very specific purposes (non-agricultural) by special permit only. Use of DDT is illegal in New York State except in medical emergencies. The possible sources of this pesticide are under further investigation.

(iii) Organics - "Non-routine" Parameters

In addition to the identification and quantification of "routine" contaminants, some further work was carried out on the qualitative analysis of a large number of "other trace organics". Results are summarized in Tables 10 and 11.

It should be stated that these analyses were conducted using capillary (vs packed column) gas-chromatography (GC). Historically, samples have been analyzed by packed column GC which for a number of technical reasons, is unable to separate out the peaks (i.e. compounds) that occur in the early part of the spectrum and elute before the hexachlorobenzene (HCB) peak. As a result, this part of the chromatographic spectrum has largely been ignored. The significance of these data is that they indicate there are numerous peaks representing as yet unidentified compounds which occur in this early part of the spectrum, in both fish and suspended sediment samples collected from the Niagara River.

To provide some perspective on the possible environmental significance of the compounds represented by these peaks observed in Niagara River suspended sediment samples including their potential for bioaccumulation, qualitative comparisons were made with forage fish (spottail shiners) collected at Niagara-on-the-Lake, the Humber River and Cobourg Creek, and sports fish (lake trout, coho salmon) caught in other locations in Lake Ontario. The analyses indicated that many of the peaks observed in this part of the spectrum in Niagara River fish were not observed in those fish caught in other locations. Furthermore, comparison of the Niagara fish data with the Niagara River suspended sediment data (Table 12) indicated that 21 of the major peaks observed in this part of the chromatograph for fish were also present in the suspended sediment (based on retention times relative to HCB, i.e., peaks with roughly the same relative retention times are probably the same compound). Table 12 also provides an indication of peak area ratios. In general, the larger the ratio of peak areas, the greater the probable potential for bioaccumulation. Stated simply from a biological point-of-view, these are the compounds that should be looked at and addressed first in Niagara River sediment and fish.

4.0 Bottom Sediments

Further analysis of 1979 bottom sediment data (Figure 13 and Table 13) showed that concentrations of PCBs, arsenic, chromium, copper, lead and zinc in excess of Ontario guidelines for open water dredged spoils disposal were detected in samples from the lower Niagara River, Tonawanda Channel and downstream of the Buffalo River mouth. Levels of mercury in sediment samples from the lower Niagara River and Tonawanda Channel, and of nickel in sediments from the Tonawanda Channel and downstream of the Buffalo River were also in excess of provincial guidelines. Concentrations of the above contaminants did not exceed provincial guidelines in sediments obtained from the Chippawa Channel.

Detectable concentrations of α-BHC, endrin, chlordane, DDT and its metabolites, heptachlor epoxide, hexachlorobenzene (HCB), mirex and thiodan (endosulphan) were also found in 1979 in the Niagara River bottom

sediment samples. However, ∝-BHC, o,p-DDT, p,p'-DDT, endrin, heptachlor epoxide and thiodan were only detected in samples from the lower Niagara River, indicating input(s) between the upper and lower river sampling locations (i.e., between Grand Island and Lewiston/Queenston).

Analysis for chlorophenoxy acid herbicides and chlorophenols in 1979 samples indicated that, except for sediment from one station in the Tonawanda Channel which contained 62 ng/g (ppb) of 2, 4, 6 - trichlorophenol, no other sediment samples from the Niagara River contained detectable quantities of these compounds.

Qualitative capillary gas chromatography/mass spectrometry analysis of 1979 samples also indicated the presence of chlorinated benzenes such as dichlorobenzene, trichlorobenzene and hexachlorobenzene in some lower Niagara River sediments.

5.0 Biota

(a) Freshwater Clams and Cladophora Studies

Results of biomonitoring studies conducted by Environment Ontario during 1980 with freshwater clams (Elliptio complanatus) placed in cages at nine sites in the Niagara River, Welland River (exposed to Niagara River water) and a control site in Lake Erie are summarized in Table 14 (also see Figure 14). The second-highest concentration of PCBs (79 ppb = ng/g, net weight, and the highest concentratons of HCB (4 ppb), ∝- BHC (12 ppb), dieldrin (6 ppb), ∝- plus ∂ - chlordane (8 ppb), endrin (17 ppb) and heptachlor epoxide (9 ppb) were found in clams exposed for 16 days to water at the downstream (northern) end of the Tonawanda Channel in the upper Niagara River. Clams placed in the Chippawa Channel contained the highest levels of total DDT plus metabolites (11 ppb) but PCBs concentrations (23 ppb) were just above the detection limit. Clams placed in the lower Niagara River at Niagara-on-the-lake contained the highest levels of PCBs (95 ppb).

In late July of 1980, Environment Ontario personnel collected and analyzed samples of the attached filamentous shoreline alga Cladophora from a number of sites in the Niagara River, as well as control sites in Lakes Erie and Ontario (see Figure 14). As indicated by the results of this preliminary study in Table 15, metals concentrations were higher in algal samples from most of the Niagara River sites than in those from the control (background) sites in Thunder Bay, Lake Erie and Fort Mississauga, Lake Ontario, suggestive of the overall contaminants loadings to the river. Also, marked site-to-site differences in certain metals concentrations indicated source areas. For example, Buffalo River mouth algae contained higher concentrations of antimony, arsenic, chromium, cobalt, copper, lead and zinc, whereas Tonawanda Channel algae contained high cadmium and zinc concentrations as well as elevated levels of chromium, copper and mercury. The cause of the relatively high concentrations of cadmium, cobalt and copper in algae from the Chippawa Channel will be investigated during 1981.

(b) Fish

Young-of-the-year spottail shiners were again collected in 1980 from sites in the lower Niagara River (Niagara-on-the-Lake and downstream of Queenston) and a control site at Thunder Bay in Lake Erie (see Figure 14). Additional collections were also made in the upper Niagara River in the Tonawanda (Love Canal and mouth of Little River) and Chippawa Channels, the Welland River (exposed to Niagara River water) and in the lower Niagara River (Peggy's Eddy/Joseph Davis Park, N.Y.). Briefly, the analytical results summarized in Tables 16, 17 & 18 indicated:

(i) concentrations of PCBs and such organochlorine pesticides as mirex, BHC and dieldrin were found to be low or non-detectable in fish from the Chippawa Channel, Welland River and Thunder Bay, Lake Erie, sites;

(ii) of the contaminants analyzed for in 1980 (PCBs and organochlorine pesticides), only PCB residues in fish obtained from the lower Niagara River and the U.S. side of the upper Niagara River exceeded the Agreement objective (100 ng/g, wet weight, whole fish) for the protection of aquatic life and fish-eating birds. Higher concentrations of PCBs were present

in fish from the upper Niagara River adjacent to Love Canal (389 ppb) and Little River (397ppb) sites in N.Y., whereas concentrations in lower Niagara River samples (134-266 ppb) were intermediate between these and sites with background level concentrations (56-95 ppb). Mirex residues were not detected in fish from the Chippawa Channel and Welland River sites, while detectable residues were found in fish from the lower Niagara River (Trace - 11 ppb) and the remaining upper Niagara River sites (5-13 ppb);

(iii) PCBs and α-BHC concentrations were significantly higher (statistical probability: 95%) in Niagara-on-the-Lake fish in 1980 than in 1979; PCBs levels in these fish were, however, lower than those measured in the period 1975-1978; p,p'-DDT constituted a higher proportion of the total DDT + metabolites levels in fish from this location than in those from other sites in the Niagara River.

(iv) preliminary analysis of fish collected at Niagara-on-the-Lake in 1979 indicated higher concentrations of certain chlorobenzenes and chlorophenols than in those collected from Centre Creek, Lake Erie (a control location). Fish sampled in 1980 at Niagara-on-the-Lake showed a decline from 1979 levels to non-detectable levels for most tri- and tetra- chlorobenzenes, but concentrations of pentachlorobenzene, hexachlorobenzene and octachlorostyrene remained about the same.

(v) comparison of the 1980 Niagara River data with the Thunder Bay, Lake Erie control site data indicates the continuing presence of PCBs, DDT and its metabolites, mirex, HCB, BHC and chlordane inputs to the Niagara River.

In 1980, adult sports fish were collected from the Canadian side of the upper (Miller Creek) and lower (Queenston) sections of the Niagara River. As indicated by Tables 19 and 20, trace contaminants analysis of their edible portions (boneless, skinless fillet) revealed that:

(i) in the lower Niagara River,

- American eel up to 55 cm, white sucker up to 45 cm, and yellow perch up to 30 cm in length contained less than 2.0 ppm PCB, 0.1 ppm mirex and 0.5 ppm mercury (National Health and Welfare guidelines, edible portion, wet weight basis, for concentrations in fish sold for human consumption).
  In 1980, analyses of adult sport fish from the Niagara River indicated that yellow perch from both the upper and lower sections and smallmouth bass from the upper Niagara River were suitable for unrestricted consumption;

- coho salmon 55 to 90 cm and American eel greater than 55 cm in length contained more than 2.0 ppm PCB and 0.1 ppm mirex;

- although not captured, white sucker 45 to 55 cm in length were computer-projected to contain between 0.5 and 1.0 ppm mercury;

- analysis of 6 yellow perch, 5 American eel, and one specimen each of walleye, rainbow trout, northern pike and muskellunge did not detect any 2, 3, 7, 8-TCDD (tetrachlorodibenzo-p-dioxin) at the detection limit of 10 ppt (10 parts per trillion).

(ii) in the upper Niagara River,

- smallmouth bass up to 45 cm, yellow perch up to 30 cm and white sucker up to 45 cm contained less than 2.0 ppm PCB and 0.5 ppm mercury, mirex was not detected in any of these fish samples;

- as in the lower Niagara River, white sucker in the 45 to 55 cm size range were computer projected to contain between 0.5 and 1.0 ppm mercury;

- analysis of 6 yellow perch and one specimen each of smallmouth bass and white sucker did not detect any 2, 3, 7, 8-TCDD at the 10 ppt detection limit.

(iii) in Lake Ontario,

- there is considerable evidence of the far-reaching effects of trace contaminants from the Niagara River on Lake Ontario sports fish. Losses of mirex from a single manufacturing source in the Niagara River (Hooker Chemicals, in Niagara Falls, N.Y.), as well as another smaller source in Oswego, N.Y. have resulted in levels of mirex in some size classes of sports fish in excess of the Canadian and American guidelines.

- levels of PCBs detected in suspended sediments sampled in the lower Niagara River indicate that the river is a major contributor of this class of compounds to Lake Ontario ($\sim$ 530 kg per year, - 1980 COA "Environmental Baseline Report of the Niagara River") and to the problem of PCBs in larger size classes of such fish as lake trout, coho salmon, brown trout, white perch, brown bullhead and chinook ("Guide to Eating Ontario Sport Fish - Great Lakes", Government of Ontario, 1981). In addition, certain species of fish from certain areas of Lake Ontario are banned for commercial fishing and domestic sale because of their mirex and PCB content.

- The compound 2,3,7,8 - tetrachlorodibenzo-p-dioxin (TCDD) has been detected in fillets of 23 out of 61 sports fish from various locations (chiefly western Lake Ontario), albeit at concentrations below Health and Welfare Canada's limit for human consumption of 20 ppt in most samples (Table 20). (The Aquatic Ecosystems Objectives Subcommittee of the IJC has suggested that levels be non-detectable for the protection of aquatic life). Recent data presented orally at a conference on October 28/81 by Dr. Stalling of U.S. Fish and Wildlife Service, Columbia, Missouri, indicated 2, 3, 7, 8 - TCDD levels of 417 ppt in carp collected from the junction of Cayuga Creek with the Little Niagara River near Love Canal, and 53 ppt in fish taken near Fort Niagara in the lower Niagara River (results in each case are whole fish analyses of a single sample composed of 3 fish).

- The compound 2, 3, 7, 8 - TCDD is a trace by-product of the manufacture of 2,4,5 - trichlorophenol and therefore may be found in very small amounts in that chemical, its manufacturing wastes and in chemicals manufactured from 2,4,5-trichlorophenol, such as the herbicide 2,4,5-T. The 1979 New York State Interagency Task Force on Hazardous Wastes Draft Report indicated that trichlorophenols had been buried in some disposal sites in the Niagara River basin (ie: Hooker's Hyde Park, S & N, 102nd Street and Love Canal sites).

(c) Herring Gull Eggs

The June, 1980 report of the Board stated that Niagara River area herring gull eggs collected in 1979 did not contain detectable levels of any TCDD (tetrachlorodibenzo-p-dioxin) isomers (detection limit: 2 mg/kg = ppt). More recently, the Canadian Wildlife Service of Environment Canada completed a survey of several herring gull colonies throughout the Great Lakes Basin. Only 2,3,7,8-TCDD was present at trace levels in all egg samples and at elevated levels in Saginaw Bay, Lake Michigan and Lake Ontario. The data indicated that both of the latter areas were clearly localized areas of contamination. Waste disposal or major accidents during the manufacturing of 2,4,5-trichlorophenol are the most likely causes of the higher levels of TCDD found in Lake Ontario and the Niagara River is the most probable source. Previous studies on mirex in gull eggs and in fish have proved that widespread contamination of Lake Ontario can occur from the Niagara River and specifically, a point source in the River itself.

Data from the analyses of archived herring gull eggs samples collected from Scotch Bonnet Island/Lake Ontario also indicated a greater than tenfold decrease in 2,3,7,8-TCDD levels during the last decade. This decrease parallels that for the majority of organochlorine residues in Lake Ontario.

6.0 Municipal Water Supplies

Monthly sampling and analysis of raw and treated water for PCBs, mirex, organochlorine pesticides and volatile hydrocarbons at the Town of Niagara-on-the-Lake and City of Niagara Falls water treatment plants and a location in the upper Niagara River adjacent to the Town of Fort Erie was continued by Environment Ontario's West-Central Region during 1980. In addition, this program was expanded in July, 1980, to include the St. Catharines municipal water supply (as a control) which is drawn from the Welland Ship Canal. In February, 1980, 2,3,7,8-tetrachlorodibenzo -p-dioxin (dioxin) was added to the parameter list.

(a) Raw Water

Table 21 summarizes the results of the analyses of raw water at the four locations for January to December, 1980, inclusive. Comparison of these data with the completed data of January to November 1979 and with IJC and MOE objectives for the protection of aquatic life indicates that:

(i) for raw water samples from the Niagara River, the maximum observed concentrations of PCBs, dieldrin, α-BHC, γ-chlordane, endrin, heptachlor epoxide (as well as the number of detections for α-BHC), were generally higher during 1980 than in 1979, while the maximum concentrations of lindane, total DDT plus metabolites and α-endosulphan were lower in 1980 than in 1979. During 1980, occasional raw water samples from the Niagara River exceeded IJC and/or MOE aquatic life objectives for PCBs, dieldrin, endrin and heptachlor epoxide;

the maximum observed concentrations of hexane, chloroform, chlorodibromomethane, dichlorobromomethane, 1, 1, 1-trichloroethane, methylene chloride, benzene, xylene(s), sec-butanol, hexanal and benzaldehyde were higher in 1980 than in 1979, whereas the maximum observed concentrations of carbon tetrachloride, trichloroethylene and tetrachloroethylene were lower in 1980 than in 1979. Compounds which were detected at a higher frequency than others during 1980 were: hexane, chloroform, methylene chloride, benzene, toluene, xylene(s), and hexanal;

(ii) During 1980, certain organic compounds such as PCBs, hexachlorobenzene, dieldrin, β-BHC, lindane, γ-chlordane, endrin, heptachlor epoxide, trichloroethylene, tetrachloroethylene, styrene, dichlorobenzene, chlorotoluene, m-chlorotoluene trifluoride, sec-butanol, di-ethyl ether, methyl furan and carbon disulphide were not detected in the St. Catharines samples although they were detected in samples of raw water drawn from the Niagara River. Conversely, ethyl benzene, n-butanol pentane, 1,1,1-trichloroethane and diethyldisulphide were only detected once in the St. Catharines raw water supply;

(iii) 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was not detected in any of the water samples analyzed;

(iv) Sampling for radio-nuclides has been infrequent, and only raw water samples have been analyzed for them. Aquatic life objectives are not presently available for radionuclides; however, comparison of levels in 1979 and 1980 samples with Health and Welfare Canada maximum acceptable concentrations and MOE drinking water criteria indicates that levels of Gross β, Cesium 137, Radium 226 and Strontium 90 were within acceptable limits.

Comparison of 1979 and 1980 raw water data with <u>suggested</u> USEPA aquatic life criteria (Table 24) indicated that concentrations of benzene, chloroform, carbon tetrachloride, chlorobenzene, dichloroethane, trichloroethane, trichloroethylene, tetrachloroethylene, dichlorobenzene, dichloropropane, methylene chloride and toluene were below their respective suggested criteria.

(b) <u>Treated Water</u>

Table 22 summarizes the results of analyses of treated (drinking) water at the municipal water treatment plants of Niagara-on-the-Lake, Niagara Falls and St. Catherines for the period of January to December, 1980, inclusive. Comparison of these data with the completed data of 1979 (June to November, inclusive) and with

concentration criteria for acceptable drinking water as contained in the publications "Drinking Water Objectives" (Environment Ontario, 1978) and "Guidelines for Canadian Drinking Water Quality, 1978" (Health and Welfare Canada, 1978) indicates that:

(i) Samples of treated water from all three locations fell within the concentration criteria for organochlorine pesticides and trihalomethanes. PCBs were only detected once (at the St. Catherines plant, at 0.020 ppb) and were below the provincial interim guideline of 3 ppb.

Similar increases in the concentration of trihalomethanes (bromoform, chloroform, chlorodibromomethane and dichlorobromomethane) were noted at all three treatment plants as a result of the water chlorinaton process (cf. Table 21b for raw water concentrations). However, as noted above, the maximum combined concentration of these four compounds, (40.9 ppb during 1979 at Niagara-on-the-Lake) was below the 350 ppb maximum acceptable concentration of Health and Welfare Canada.

(ii) During 1980, certain organics such as dieldrin, lindane, δ-chlordane, endrin, heptachlor exoxide, trichloroethylene, tetrochloroethylene, styrene, dichlorobenzene, chlorotoluene, m-chlorotoluene trifluoride, sec-butanol, butanal and carbon disulphide were not detected in the St. Catharines samples although they were detected at one or both treatment plants drawing water from the Niagara River. Dichloropropane and benzaldehyde were only detected in the St. Catherines water supply.

(iii) 2,3,7,8 - tetrachlorodibenzo-p-dioxin (TCDD) was not detected in any treated water samples.

(iv) For treated water samples from Niagara-on-the-Lake and Niagara Falls, the maximum detected concentrations of dieldrin, α-BHC, lindane, δ-chlordane endrin, hexane, pentane, 1,1,1-trichloroethane, methylene chloride, benzene, xylene(s) and hexanal were higher in 1980 than in 1979, whereas the maximum detected concentrations of trichloroethylene, tetrachloroethylene, ethyl benzene, cumene, toluene and ethyl toluene were lower in 1980 than in 1979.

No drinking water objectives have as yet been established by Health and Welfare Canada or Environment Ontario for a number of organics detected in some raw and treated water samples drawn from the Niagara River and at St. Catherines at part per trillion (ppt) or part per

billion (ppb) levels during 1979 and 1980. However, the significance of the 1979 concentrations of organics (reported in the 1980 "Environmental Baseline Report on the Niagara River") was investigated by medical consultants to Environment Ontario. Their findings indicated that with the exception of methylene chloride, the maximum 1979/1980 concentrations of α-BHC, β-BHC, endosulphan, carbon tetrachloride, dichloroethane, trichloroethane, trichloroethylene, tetrachloroethylene, benzene, toluene, chlorobenzene and di-ethyl ether in treated water samples were below the lowest suggested limits in a sampling of recent literature (see Table 23). A further comparison of treated water data with criteria under consideration by U.S.E.P.A (Table 24) indicated that most samples from 1979 and 1980 were below the suggested levels. However, concentrations of compounds such as bromodichloromethane, methylene chloride and PCBs exceeded their respective suggested criteria in some samples.

C. INPUTS (INDUSTRIAL AND MUNICIPAL)

1. Background

The magnitude of point and non-point sources differs on the two sides of the Niagara River. On the U.S. side, 12 municipal wastewater treatment plants and 89 industrial facilities are reportedly licenced by New York State to discharge their effluents to the Niagara River, or its immediate tributaries. Numerous ($\sim$312) other industrial operations discharge indirectly to the river via municipal wastewater treatment plants, eleminating the need for individual permit requirements. In contrast to New York State, there are 3 municipal and 12 industrial discharges on the Canadian side of the river. Total effluent flow from all U.S. point sources to the Niagara River, at 1499 x 10^3 m^3 per day, is over six times that from all Canadian point sources (236 x 10^3 m^3 per day) - (1979 IJC Inventory of Point Source Dischargers to the Great Lakes).

A 1979 New York State report, "Interagency Task Force on Hazardous Wastes Draft Report", identified 215 chemical waste dumps in the Niagara/Erie counties area. Of these, at least four are known to have leaked contaminants into the Niagara River (Love Canal, Hyde Park, 102nd Street and "S" Area) and were rated as priority I. In Contrast to the above, there are a total of 12 municipal and industrial waste disposal sites on the Canadian side of the river.

Figures 15 to 18 (derived from Niagara River Toxics Committee maps) indicate the locations of intakes, outfalls and disposal sites near the Niagara River or its tributaries in both Ontario and New York State. Although industrial and combined sewer discharges have not been differentiated due to space limitations, wastewater/sewage treatment plant discharges, water treatment plant intakes and major disposal sites have been labelled.

2. Trace Contaminants Loadings

In accordance with the COA Review Board's conclusion #5 in the 1980 report, Environment Ontario has completed a preliminary trace contaminants survey of 15 industrial and 3 municipal sewage treatment plant and 2 combined sewer discharges entering the Niagara River or its tributaries. Sampling (3-part grab sample at each discharge) was conducted from January 26 to February 24, 1981 and samples were analyzed for a broad range of parameters, including heavy metals, arsenic, cyanide, phenols, PCBs, pesticides and other organics. Total Ontario loadings based on this survey are shown in Table 25.

Toxic substances loading data from a May 1981 U.S. E.P.A. sampling of 10 "major" dischargers on the New York side of the river is not as yet available. Compilation of loading information for New York sources is therefore limited to the results of an Environment Canada analyses of effluent samples from the City of Niagara Falls, N.Y. sewage treatment plant and data on the Hooker Chemicals and Plastics Corp.,

Niagara Falls plant, taken from the recently published New York Public Interest Research Group report on the Niagara River. These data are shown in Tables 26 and 27.

In order to examine the significance of Ontario and New York inputs in relation to each other and to the total contaminants load carried by the Niagara River, a comparison is made in Table 28 with the loading measured at the river mouth. In the case of many of the organic compounds studied, sampling at the river mouth revealed that the compound was frequently not present at detectable levels as previously indicated in Table 21b. A conservative estimate of the river load was, however, made in each case by assuming that non-detection equated to zero load. A similar approach was used to estimate the toxics load entering the river from Lake Erie.

When compared to the load carried by the Niagara River at its mouth, Ontario point sources are generally shown to contribute a very small portion ie. from $< 1\%$ to 4% of the total. The reason(s) for the relatively high percentage contribution for the common solvents trichloroethylene ($\sim 30\%$) and tetrachloroethylene ($\sim 13\%$) are not clear, but may reflect volatilization of these compounds occurring soon after discharge.

Metals loadings from the City of Niagara Falls, N.Y. sewage treatment plant are essentially equivalent to the total from all Ontario point sources with the exception of aluminum, chromium and iron. Ontario inputs of these three metals are approximately an order of magnitude greater than the Niagara Falls, N.Y. sewage treatment plant discharge. In contrast to the metals loading, the trace organics loading from the Niagara Falls, N.Y. STP is shown to be about one order of magnitude greater than the total Ontario input for most of the compounds for which data are available (two orders of magnitude greater in the case of phenols). Both the sewage treatment plant and the Hooker Chemicals and Plastics Corp., Niagara Falls plant are observed to contribute high inputs of tri- and tetrachloroethylene relative to the river mouth load as was also indicated above for the Ontario discharges.

Although drainage from Lake Erie would appear to constitute a major input of trace contaminants, with the exception of dieldrin, the load of all organics carried by the river increases between Fort Erie and Niagara-on-the-Lake. This is particularly evident for such compounds as PCBs, hexachlorobenzene, 1,1,1-trichloroethane, tetrachloroethylene and the xylenes. With the possible exception of trichloroethylene and tetrachloroethylene, even if one assumes no loss of these compounds (as a result of volatilization, adsorption and sedimentation) between their discharge point and Niagara-on-the-Lake, the total of Ontario municipal and industrial discharges combined with the Niagara Falls, N.Y. sewage treatment plant and Hooker Chemicals, Niagara Falls plant discharges cannot account for this increase. Results of the U.S. E.P.A. May 1981 survey of several major municipal and industrial discharges along with survey data to be collected in Fall 1981 by New York State Dept. of Environmental Conservation are expected to assist in better defining the trace contaminants loading situation.

D. RESPONSE TO IJC SPECIAL REPORT ON POLLUTION IN THE NIAGARA RIVER

On January 20, 1981, the International Joint Commission released a Special Report on Pollution in the Niagara River stating its concern "about the quality of the Niagara River and its effects on Lake Ontario". The report made several recommendations to the jurisdictions and the Parties. The Review Board takes this opportunity to address those recommendations which it feels comes under its purview to so do, specifically recommendations (1) and (2).
Recommendations (1) and (2) state:

"The Commission recommends that:

(1) a comprehensive and coordinated study of the Niagara River as a total system be undertaken, including identification of sources, concentrations, fate and probable effects of all detected organic compounds and metals, so that all jurisdictions and the Commission can assess the current problem and the required remedial actions and so that the jurisdictions can implement appropriate remedial or preventative action on a common basis; and

(2) a comprehensive and continuing monitoring program for the entire Niagara River and western end of Lake Ontario be developed and maintained, coordinated and supported by all relevant jurisdictions either within or coordinated with the Great Lakes International Surveillance Program. This program should, to the extent possible, reflect current understanding of interactions among pollutants and the need for a better understanding of pollutants present within the water bodies concerned but for which Specific Objectives or human health or biological criteria do not yet exist, and also should provide for sufficient interpretation of data to assess the effects of pollutants on the ecosystem of the Niagara River and Lake Ontario".

The Canada/Ontario Surveillance Committee, under the Canada/Ontario Review Board, and the Great Lakes Surveillance Work Group under the Great Lakes Water Quality Board are the two primary mechanisms for coordinating Canadian and Canada/U.S. Surveillance activities on the Great Lakes including those in the Niagara River. In recognition of the concerns over environmental quality problems in the Niagara River, and the need to focus more intensive binational effort in this area, the Canada/Ontario Review Board in conjunction with the NYDEC and USEPA (Region II and Region V) initiated the formation of an ad hoc Niagara River Toxics Committee. The immediate concerns of this group in the short term has been to ensure a coordinated Canada/U.S. approach to dealing with the toxics issue in the Niagara River. Specifically, considerable time has been spent on addressing a coordinated field program for 1981/82 which will address not only the inputs (including point and non-point discharges to the River) but also ambient conditions in the River. The Environmental Contaminants Division of the National Water Research Institute (NWRI) is also focussing much of its research effort on the identification and fate of persistant organic substances in Lake Ontario at the mouth of the Niagara River. The longer term goal of this committee is to address the development and implementation of a "continuing monitoring program for the entire Niagara River" to obtain a better indication on the ambient conditions, the effectiveness of present pollution abatement programs and the need for additional pollution abatement measures.

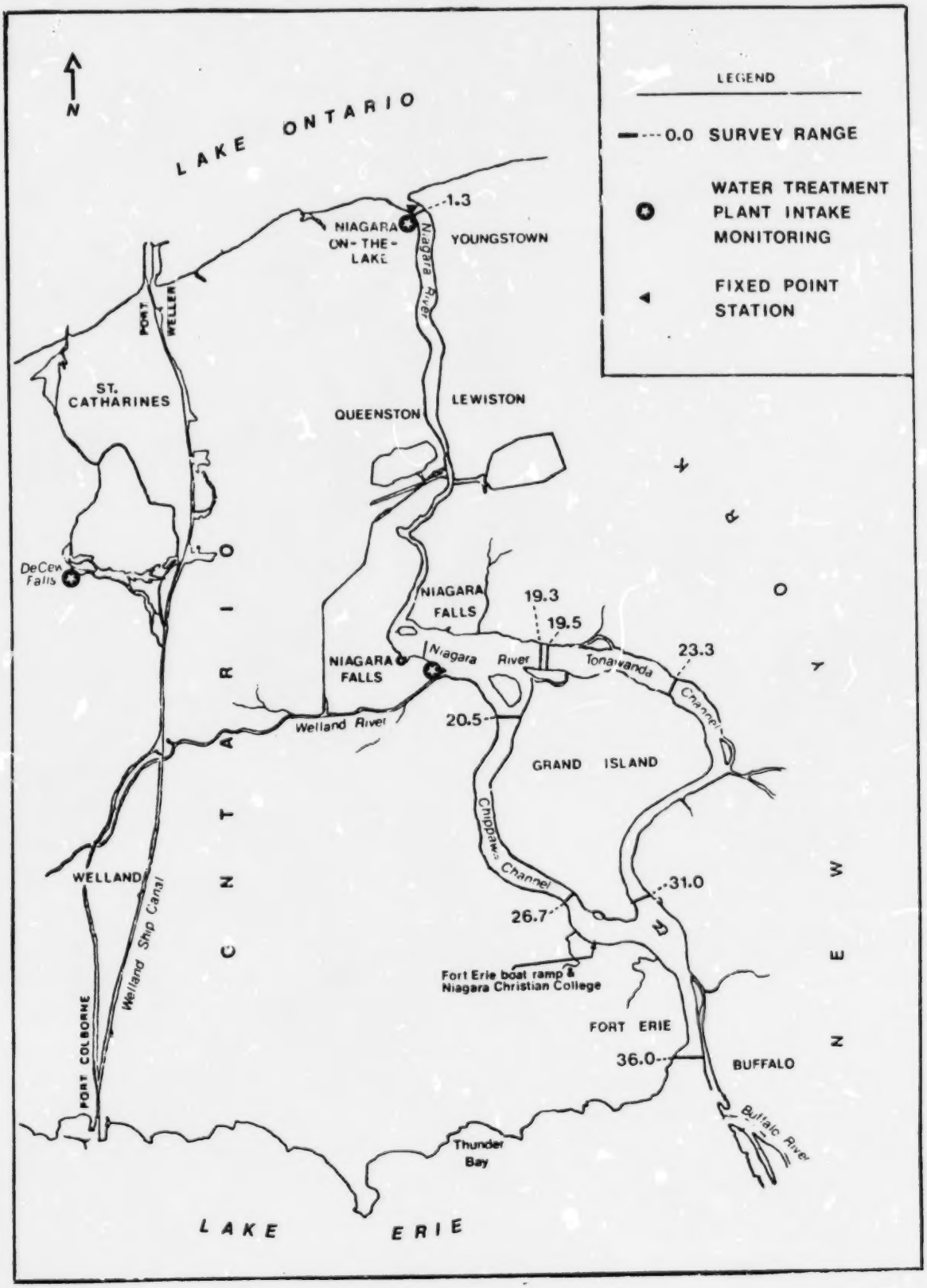


FIGURE 1. NIAGARA RIVER WATER QUALITY MONITORING LOCATIONS - 1979/80.

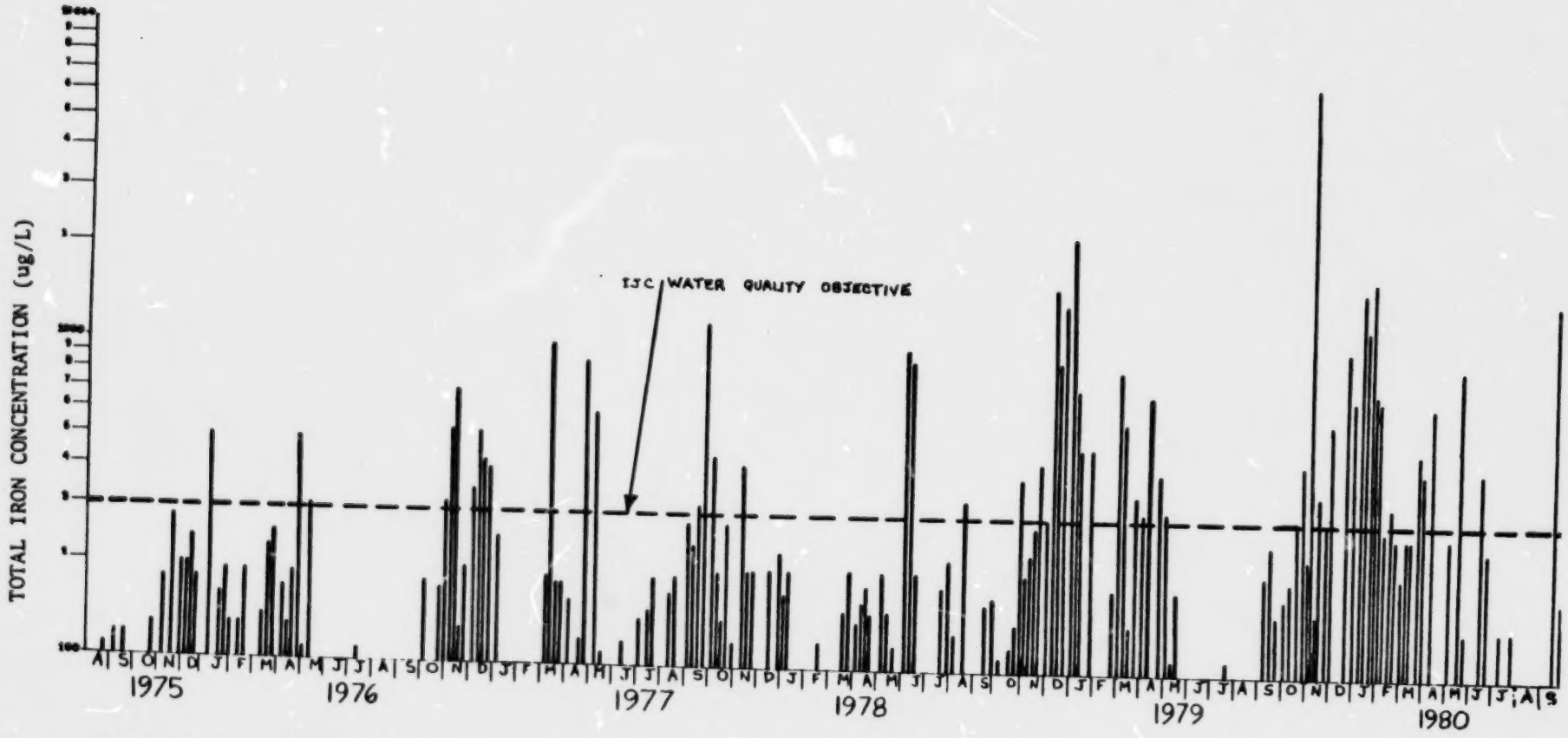


FIG. 2. Concentration of Total Iron in Water Samples Collected Weekly at Niagara-on-the-Lake vs Time from 1975-1980

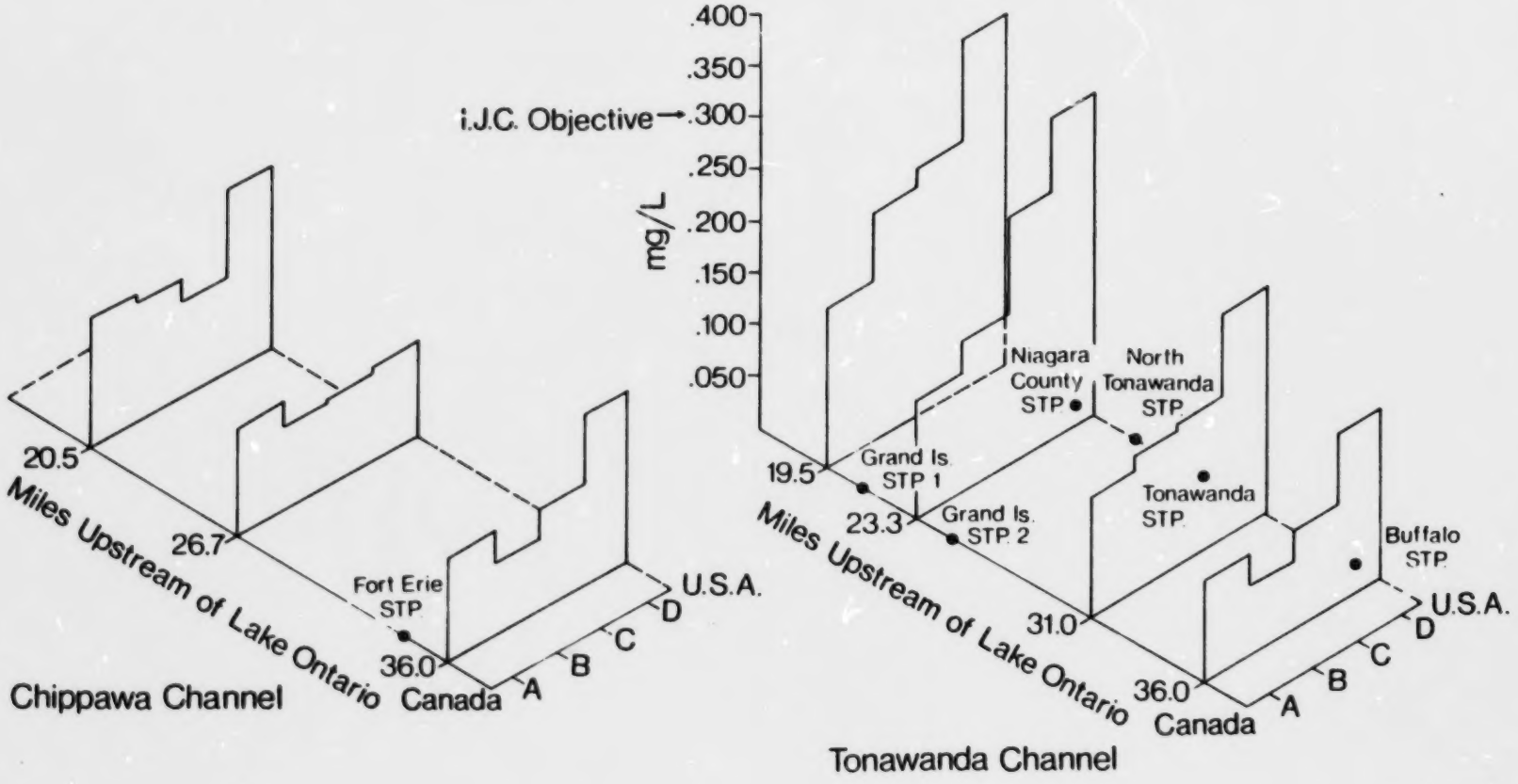


Figure 3. 1979 UPPER NIAGARA RIVER - MEAN TOTAL IRON (mg/L)

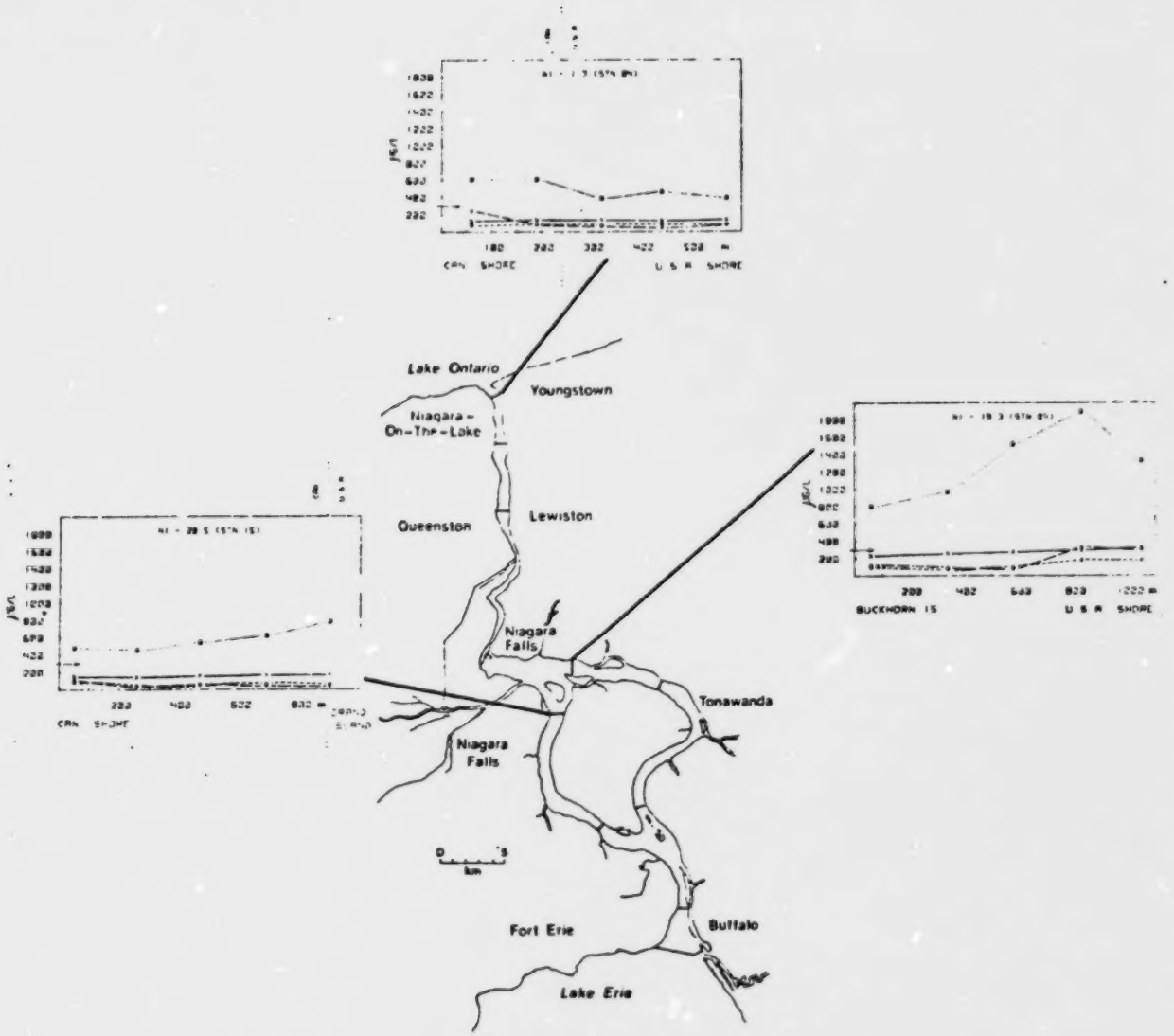


Fig. 4 . Mean (3 samples) of Total Iron concentrations (ug/l) in Niagara River surface waters (1.5 m depth) during 1980:

	(×) June	(+) Aug.	(•) Sept.	(■) Oct.
lower Niagara	16-19	3-5	13-15	18-20
upper Niagara	22-24	6-8	19-21	25-30

Arrow (⟶) indicates IJC Objective.

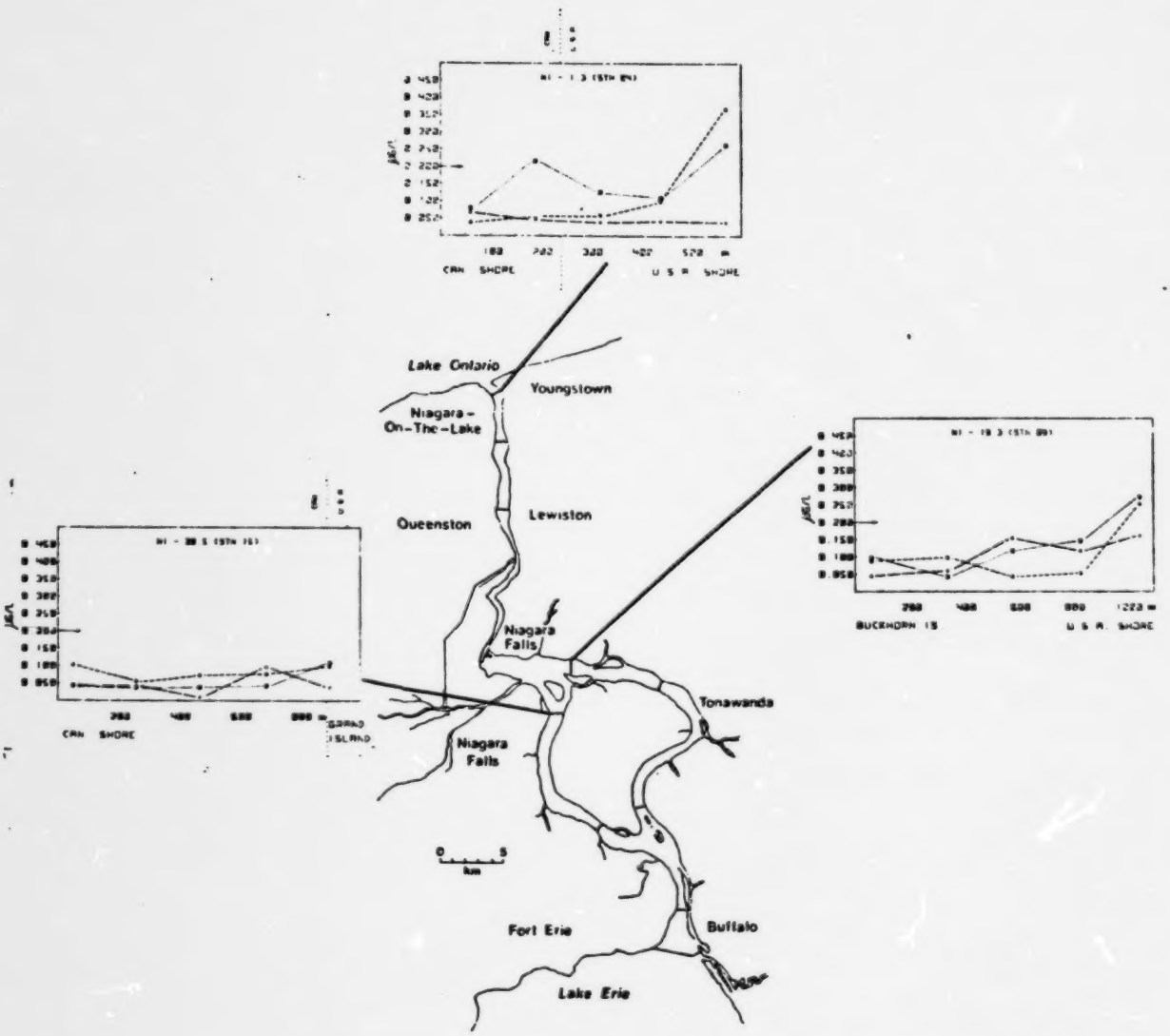
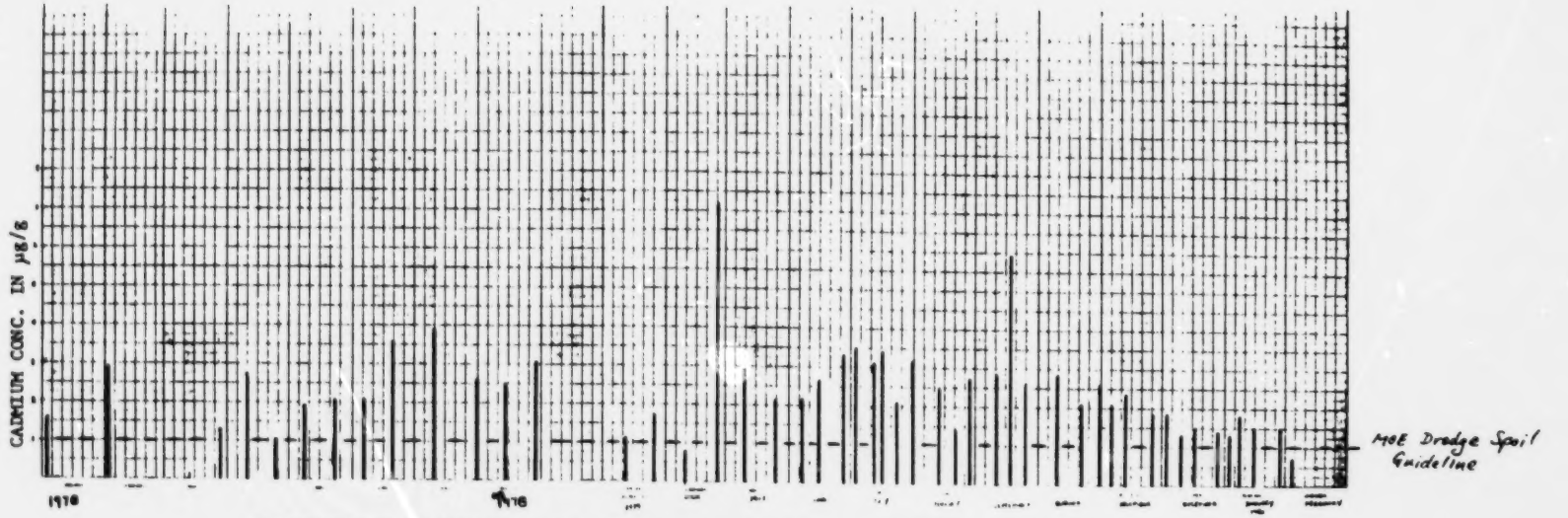


Fig. 5 . Mean (3 samples) of Filtered Mercury concentrations (ug/l) in Niagara River surface waters (1.5 m depth) during 1980:

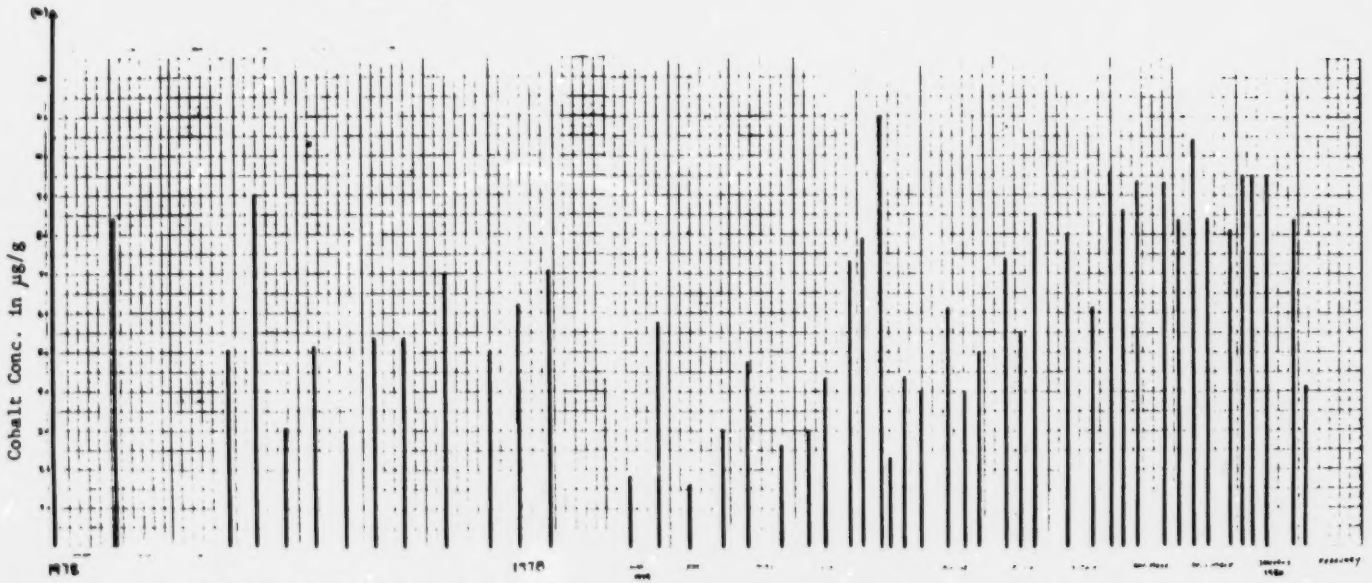
	(—+—) Aug.	(—•—) Sept.	(—■—) Oct.
lower Niagara	3-5	13-15	18-20
upper Niagara	6-8	19-21	25-30

Arrow (⟶) indicates IJC Objective.

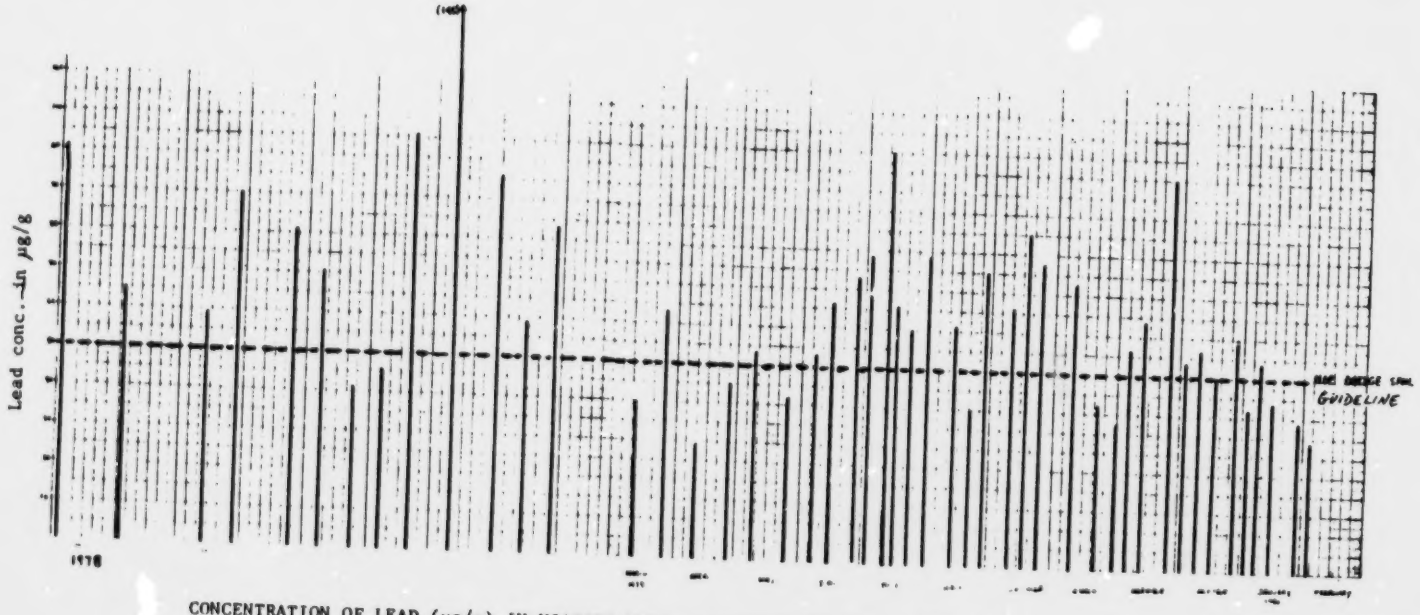
FIGURE 6.



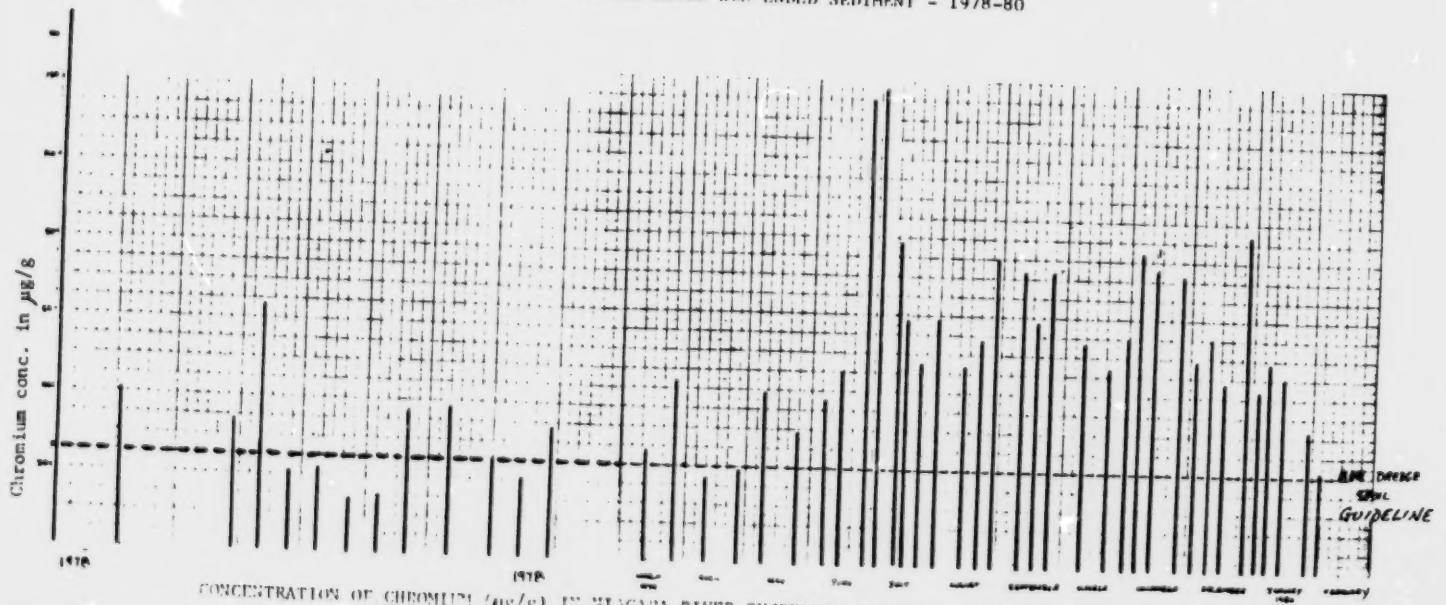
CONCENTRATION OF CADMIUM (ug/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80



CONCENTRATION OF COBALT (µg/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80



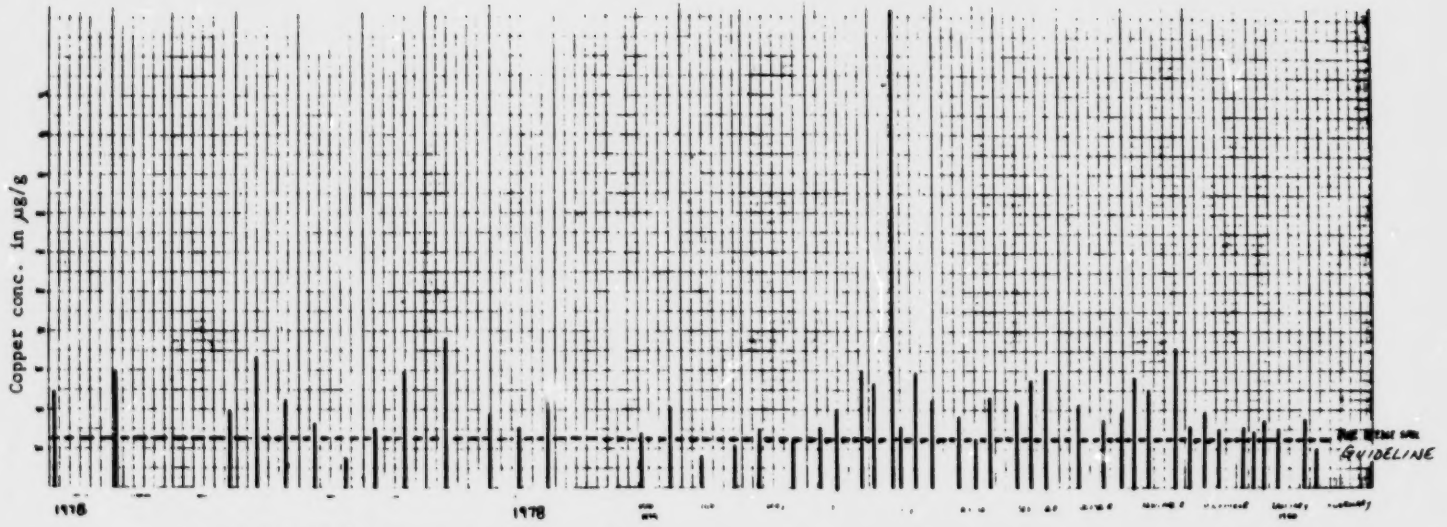
CONCENTRATION OF LEAD (ug/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80



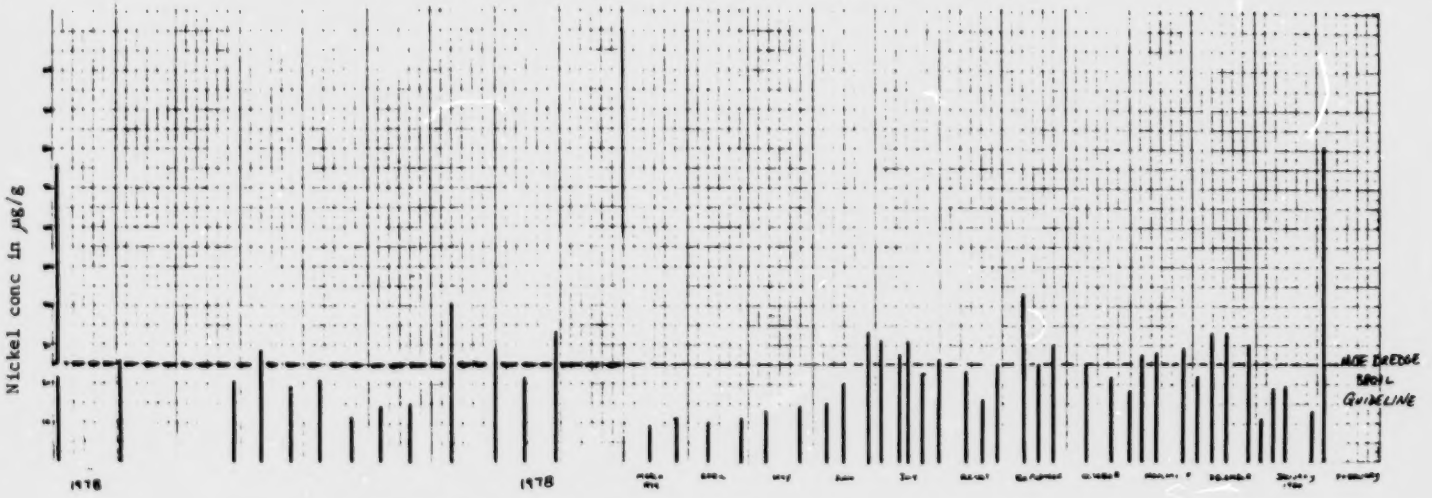
CONCENTRATION OF CHROMIUM (ug/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80

FIGURE 7.

FIGURE 8.

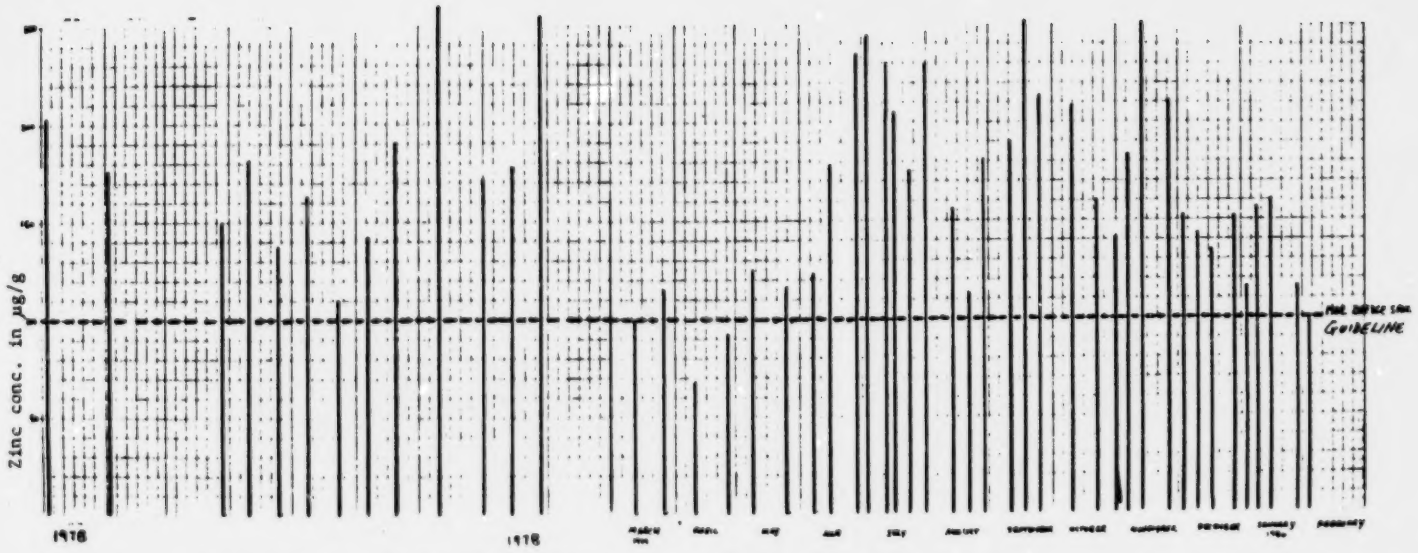


CONCENTRATION OF COPPER (ug/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80

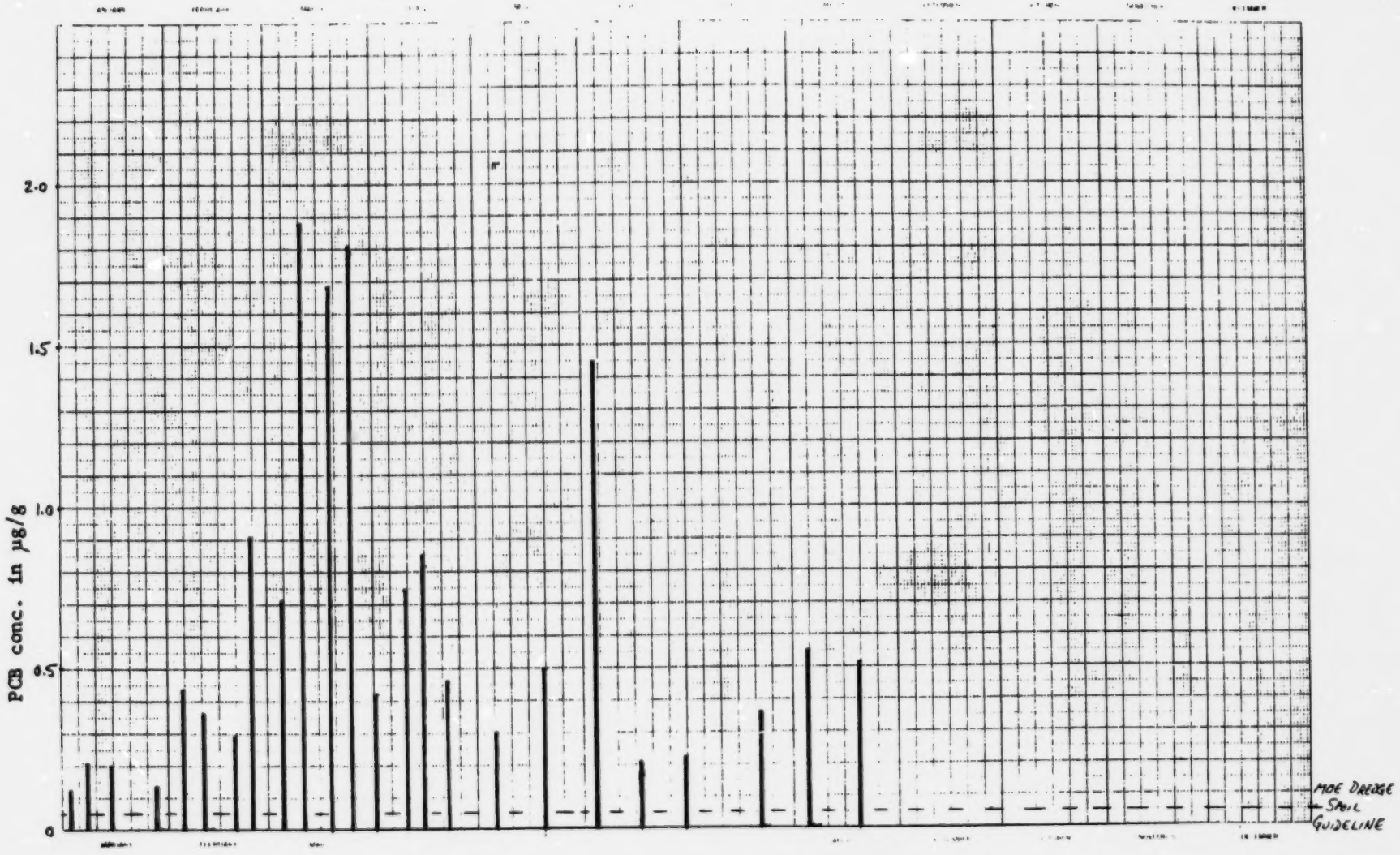


CONCENTRATION OF NICKEL (µg/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80

FIGURE 9.

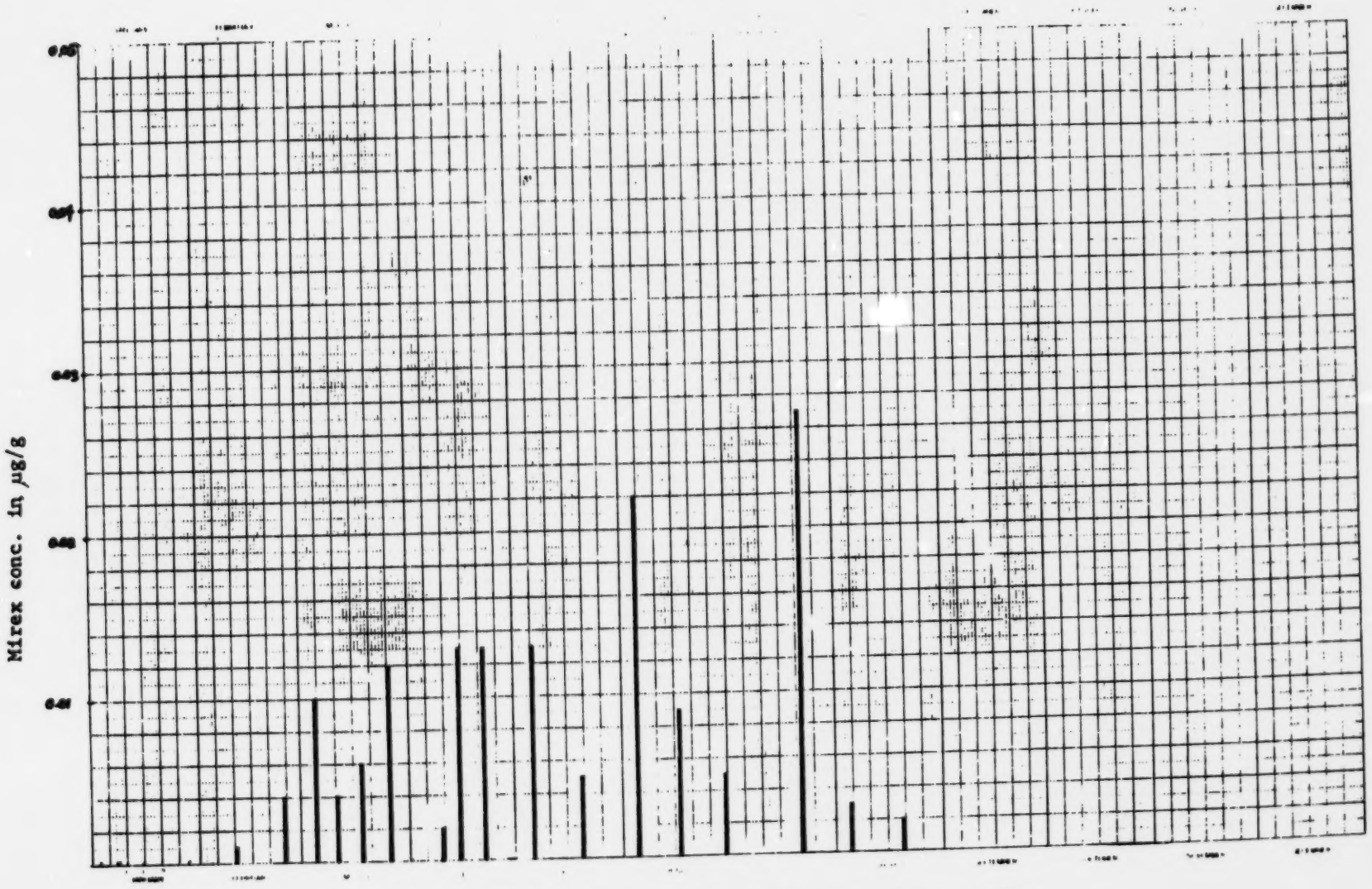


CONCENTRATION OF ZINC (µg/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1978-80



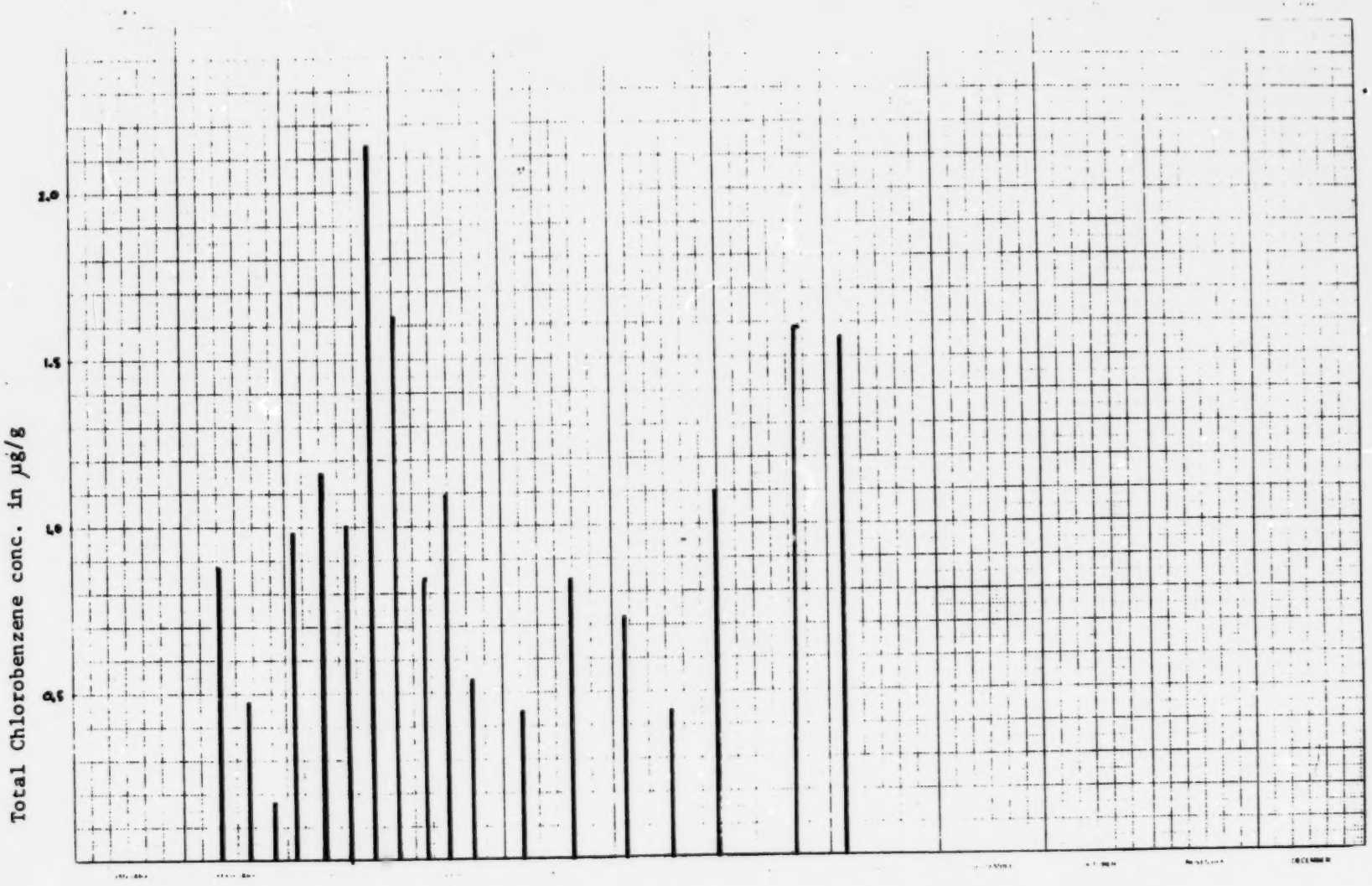
CONCENTRATION OF TOTAL PCB (µg/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1980

FIGURE 10.



CONCENTRATION OF MIREX (µg/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1980

FIGURE 11.



CONCENTRATION OF TOTAL CHLOROBENZENES (µg/g) IN NIAGARA RIVER SUSPENDED SEDIMENT - 1980

FIGURE 12.

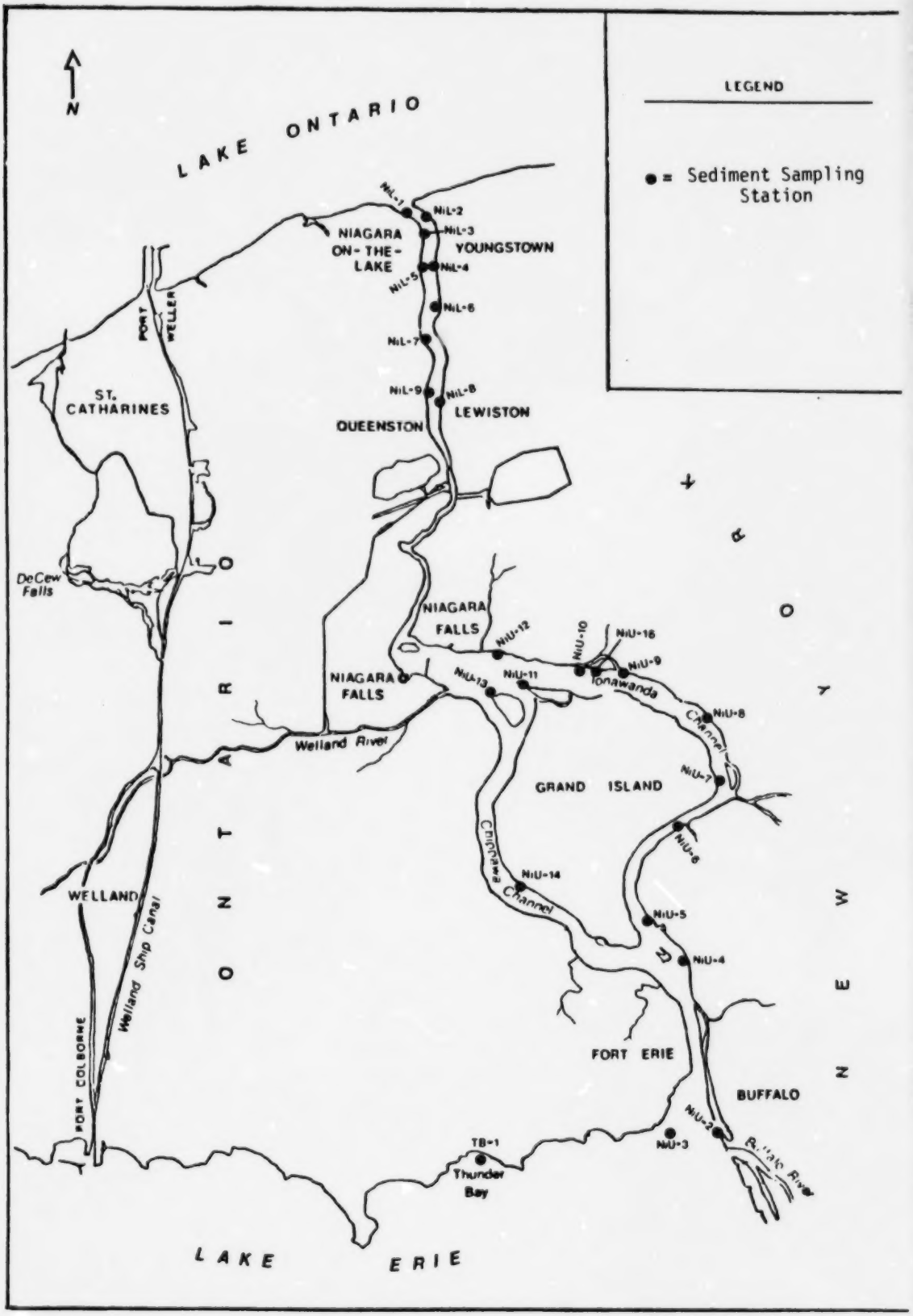


FIGURE 13. NIAGARA RIVER BOTTOM SEDIMENT SAMPLING – 1979.

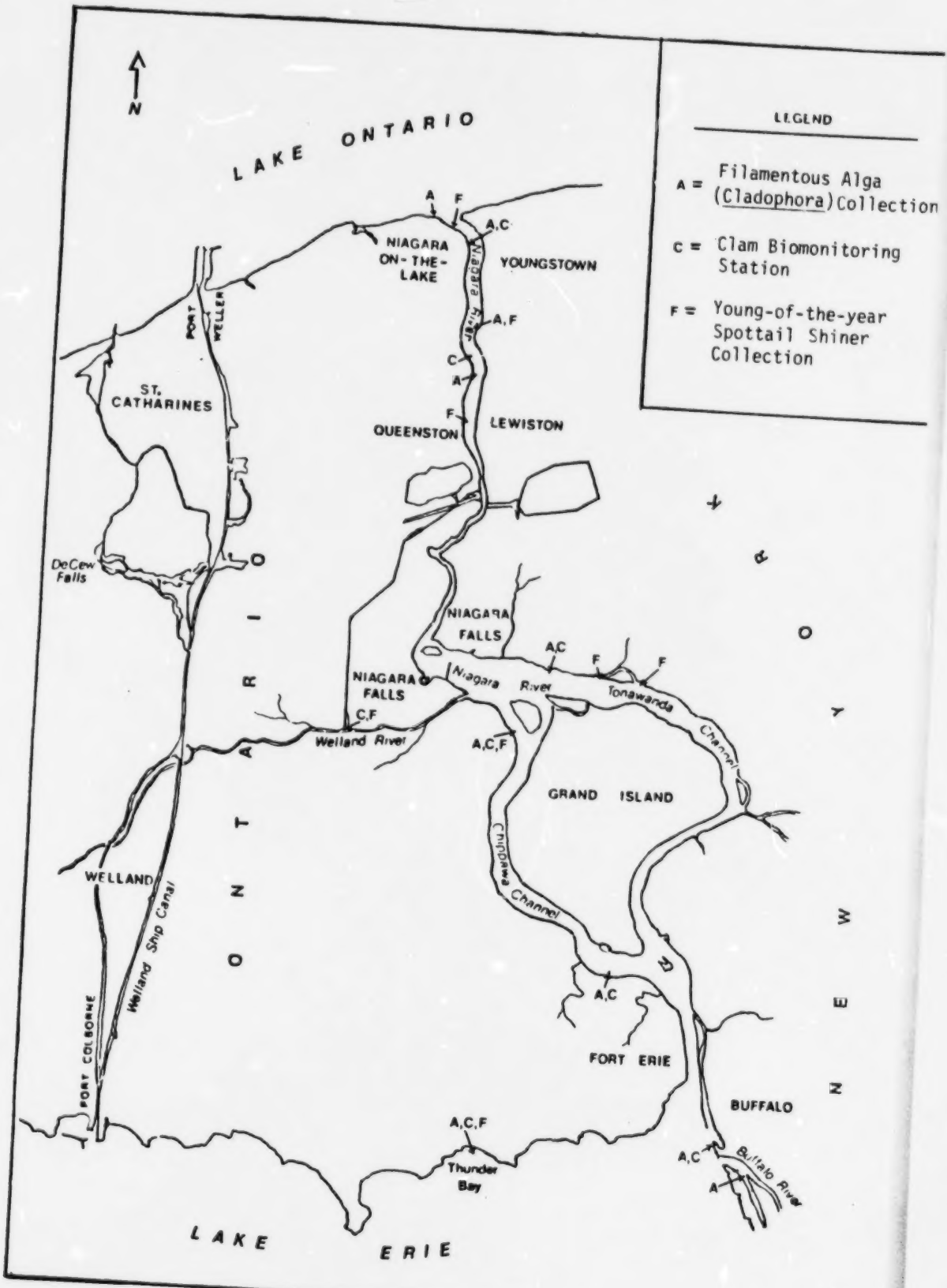


FIGURE 14. NIAGARA RIVER BIOMONITORING LOCATIONS – 1980.

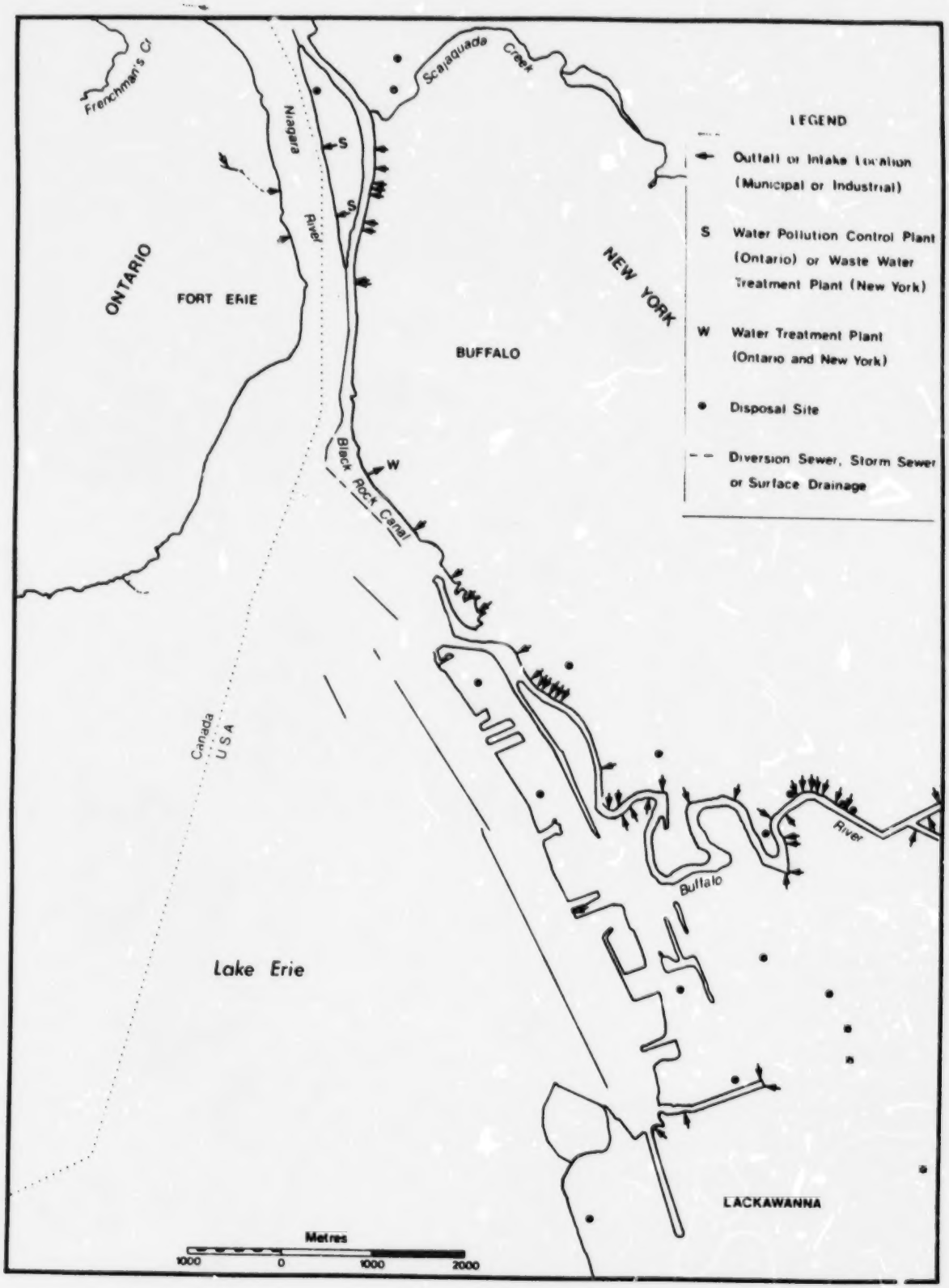


FIGURE 15. INTAKES, OUTFALLS AND DISPOSAL SITES IN THE UPPER NIAGARA RIVER - BUFFALO HARBOUR AREA (Source: Niagara River Toxics Control Committee, 1981).

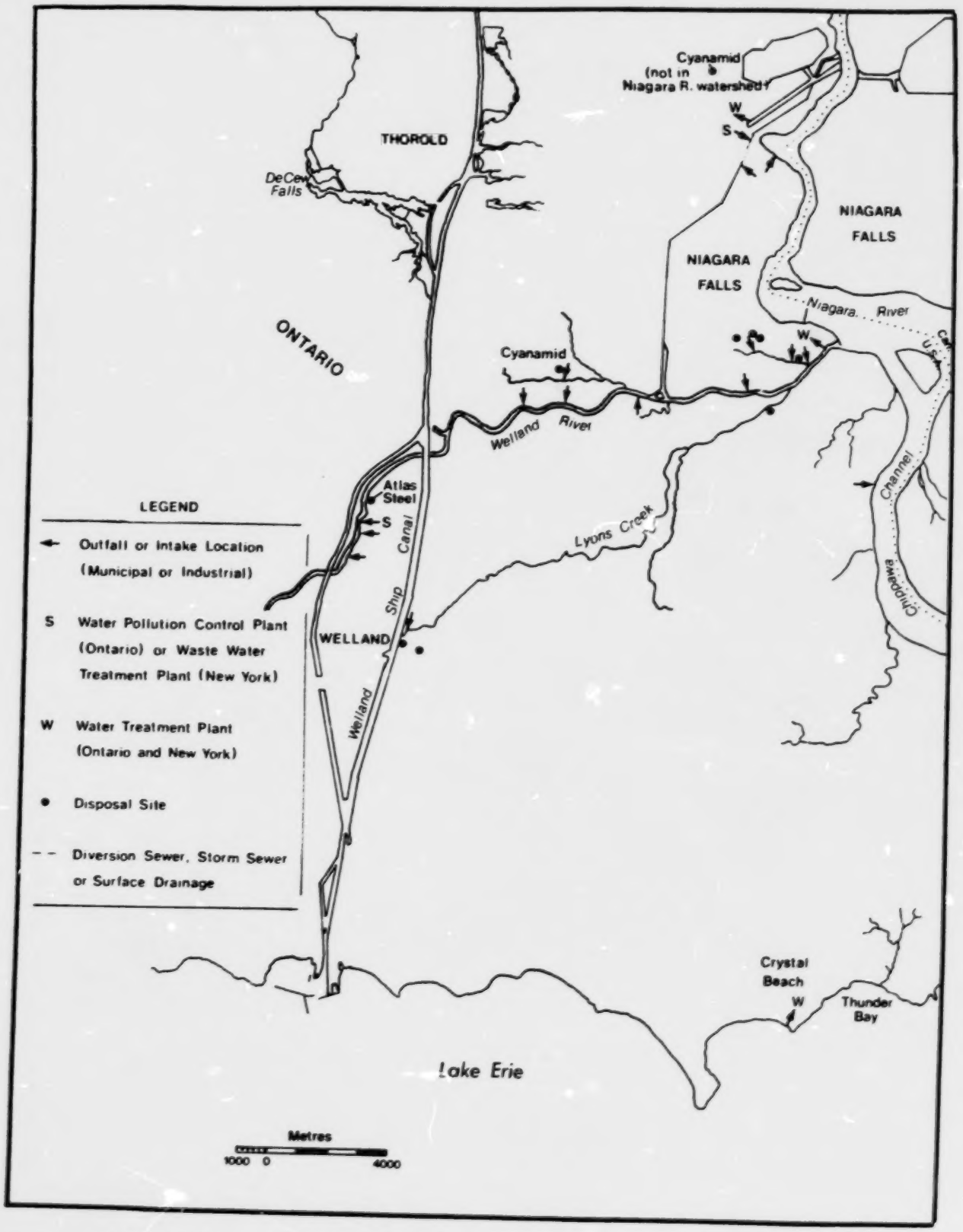


FIGURE 16. INTAKES, OUTFALLS AND DISPOSAL SITES IN THE UPPER NIAGARA RIVER (Source: Niagara River Toxics Control Committee, 1981).

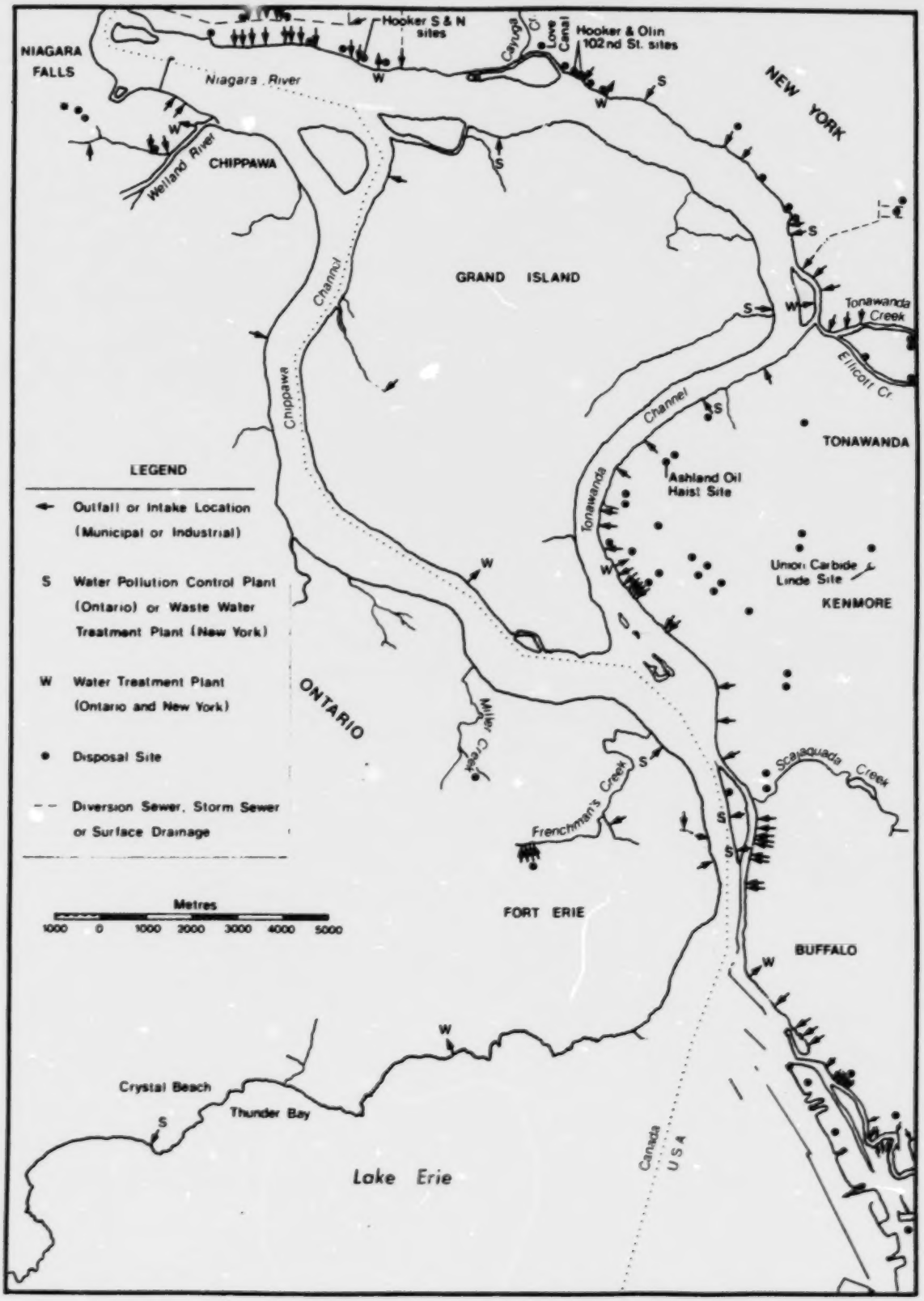


FIGURE 17. INTAKES, OUTFALLS AND DISPOSAL SITES IN THE UPPER NIAGARA RIVER (Source: Niagara River Toxics Control Committee, 1981).

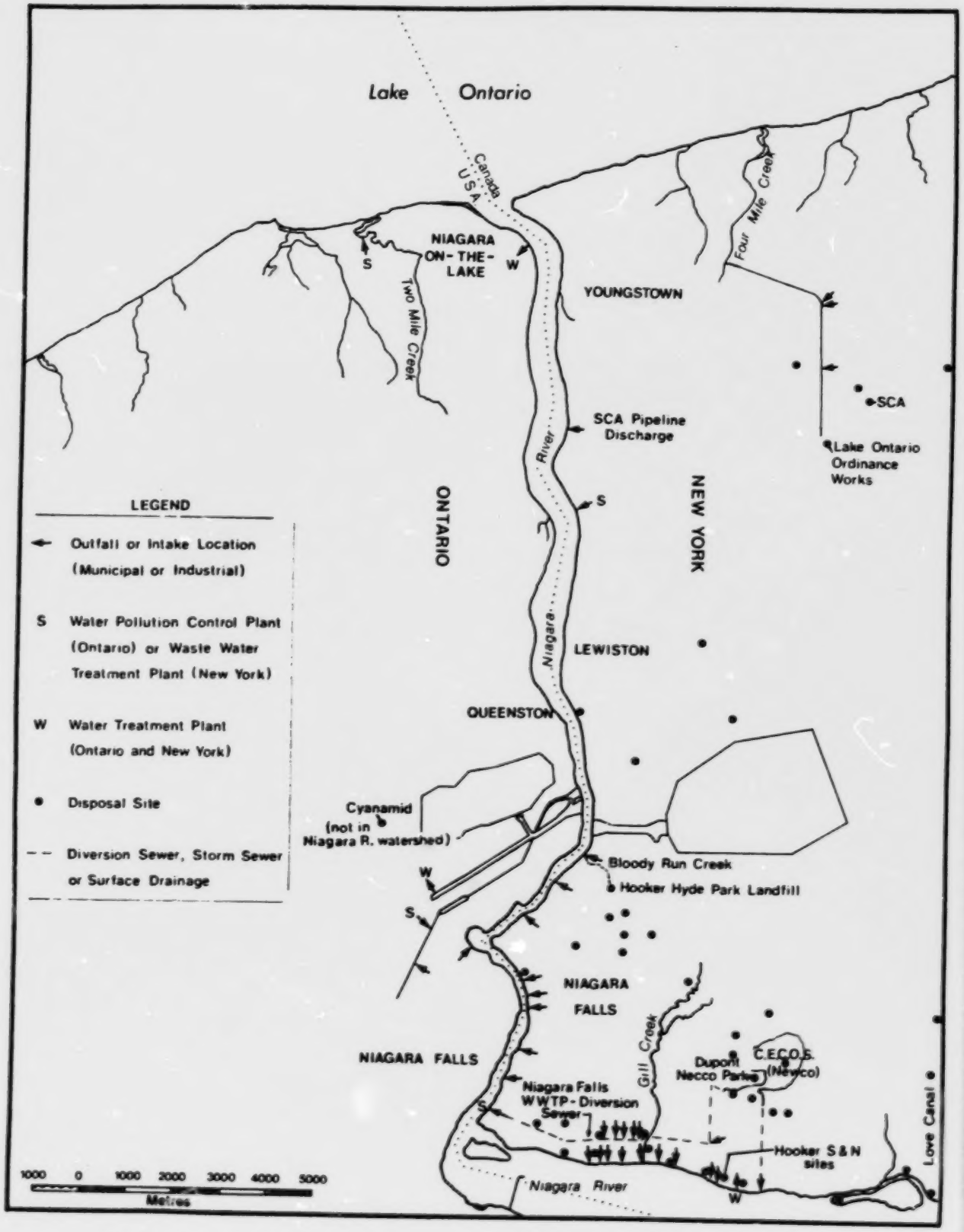


FIGURE 18. INTAKES, OUTFALLS AND DISPOSAL SITES IN THE LOWER NIAGARA RIVER (Source: Niagara River Toxics Control Committee, 1981).

TABLE 1. MEAN ANNUAL CONCENTRATION (mg/L) OF TRACE METALS IN WATER SAMPLES COLLECTED IN THE NIAGARA RIVER AT NIAGARA-ON-THE-LAKE AND IN LAKE ONTARIO AT THE MOUTH OF THE NIAGARA RIVER DURING 1975-1980

PARAMETER/YEAR	1975	1976	1977	1978	1979 *	1980 * incomplete	LAKE ONTARIO STATION 1979(2)
NO. OBS.	19	51	48	43	39	41	
ALUMINUM	.085	.100	.082	.082	.176(.115)	.155	.049
CADMIUM	L .001	L .001	L .001	L .001	L .001	L .001	L .001
CHROMIUM	.003	.002	.003	.002	.001	.005	L .001
COPPER	.004	.007[1]	.010[1]	.005	.006[1]	.003	.001
IRON	.128	.177	.214	.282	.504(.336)[1]	.391[1]	.125
LEAD	.002	.002	.002	.002	.001	.001	L .001
MANGANESE	.005	.011	.007	.015	.020 (.011)	.024	.004
NICKEL	.002	.003	.004	.002	.003	.003	.002
ZINC	.004	.005	.007	.006	.004	.005	.001
MERCURY (EXT.)					L.00005	L .00005	L .00005
CYANIDE (DISS-UF)					.002	.003	--

[1] Violation of 1978 Agreement objectives

(2) Mean of surface values for three cruises

( ) Edited values (one high value left out)

* Detection Limit values entered as 0 for mean calculation

1980 Data set includes data from Jan 3-Oct 7/80

L-less than detection limit

TABLE 2. PERCENTAGE OF WEEKLY WATER SAMPLES VIOLATING 1978 AGREEMENT OBJECTIVES IN THE NIAGARA RIVER, AT NIAGARA-ON-THE-LAKE DURING 1975-1980

PARAMETER	1978 IJC SPEC OBJECT ug/L	MOE OBJECT ug/L	% VIOLATIONS AT NIAGARA-ON-THE-LAKE					
			1975	1976	1977	1978	1979	1980*
CADMIUM-T	0.2	0.2	0	6	6	0	5	0
CHROMIUM-T	50	100	0	0	0	0	0	2
COPPER-T	5	5	16	61	79	40	33	17
IRON-T	300	300	0	20	15	19	41	34
LEAD-T	25	25	0	0	0	0	0	0
NICKEL-T	25	25	0	0	2	0	0	0
ZINC-T	30	30	0	0	2	0	0	0
MERCURY-EXT	0.2	0.2	-	-	-	-	0	0
CYANIDE	-	5						

* incomplete data set (includes data from Jan 3- Oct 7/80)

TABLE 3.

MEAN CONCENTRATION *(µg/l=ppb) of PCBs, PESTICIDES
ARSENIC, CYANIDE AND HEAVY METALS IN NIAGARA RIVER SURFACE WATER (1.5 m. depth)
DURING 1980

Parameter	1978 IJC Spec. Objective	1978 MOE Aquatic Life Objective	River Range 1.3	19.3	20.5
PCBs	-	0.001	<0.020 (0)	<0.020 (9)	<0.020 (7)
Aldrin	0.001	0.001	<0.001 (4)	<0.001 (0)	<0.001 (7)
Dieldrin			<0.001	<0.001	<0.001
∝-BHC	-	-	0.004 (78)*	0.004 (67)*	0.003 (64)*
ß-BHC	-	-	<0.001 (9)*	<0.001 (9)*	<0.001 (10)*
Lindane(γ-BHC)	0.010	0.010	<0.001 (0)	<0.001 (0)	<0.001 (0)
∝-Chlordane	0.060	0.060	<0.001 (0)	<0.001 (0)	<0.001 (0)
γ-Chlordane			<0.001	<0.001	<0.001
o.p-DDT	-	-	<0.005 (2)*	<0.005 (0)*	<0.005 (0)*
p.p-DDT	-	-	<0.005 (0)*	<0.005 (2)*	<0.005 (5)*
p.p-DDE	-	-	<0.001 (2)*	<0.001 (4)*	<0.001 (0)*
p.p-DDD (TDE)	-	-	<0.005 (2)*	<0.005 (0)*	<0.005 (0)*
ΣDDT+metabolites	0.003	0.003	<0.005 (2)	<0.005 (4)	<0.005 (5)
Endrin	0.002	0.002	<0.001 (2)	<0.001 (2)	<0.001 (0)
Heptachlor	0.001	0.001	<0.001 (9)	<0.001 (7)	<0.001 (21)
Heptachlor epoxide			<0.001	<0.001	<0.001
HCB	-	-	<0.001 (0)*	<0.001 (4)*	<0.001 (0)*
Mirex	<detection limit	0.001	<0.005 (0)	<0.005 (0)	<0.005 (0)
Thiodan I(∝-Endosulphan)	-	0.003	<0.001 (2)	<0.001 (0)	<0.001 (0)
ThiodanII(ß-Endosulphan)	-		<0.001 (2)	<0.001 (0)	<0.001 (0)
Phenols	-	1	<1 (25)	<1 (10)	<1 (8)
Arsenic	50	100	<1 (0)	1 (0)	<1 (0)
Cyanide	-	5	<10 (0)	<10 (0)	<10 (0)
Aluminum	-	-	164	303	188
Cadmium	0.2	0.2	<0.2 (7)	<0.2 (7)	<0.2 (10)
Chromium	50	100	<20 (2)	<20 (8)	<20 (8)
Copper	5	5	2 (7)	2.5 (10)	5.4 (10)
Iron	300	300	165 (15)	469 (32)	217 (22)
Lead	25	25	<3 (0)	<3 (0)	<3 (0)
Mercury (filtered)	0.2	0.2	0.10 (13)	0.11 (18)	0.06 (7)
Nickel	25	25	<20 (0)	<20 (0)	<20 (0)
Zinc	30	30	<10 (0)	<10 (2)	<10 (0)

* Where necessary, one half of detection limit values were used for mean calculation.
Numbers in brackets ( ) indicate percent of samples at or above objective.
Numbers in brackets ( )* indicate percent of samples at or above detection limit.
Values prefixed by "<" are MOE detection limits.
Dash,"-",indicates no objective available.

TABLE 4.

SUMMARY OF 1980* ORGANIC CONTAMINANTS DATA IN WATER SAMPLES AT NIAGARA-ON-THE-LAKE DAILY STATION (µg/L)

PARAMETER	CONFIRMED DETECTIONS			
	No.	%	Mean	St. Dev.
PCB (TOTAL)	29	93	.010	.007
ALDRIN	1	3	L.001	--
DIELDRIN	21	67	.001	0
α-BHC	31	100	.011	.006
γ-BHC (LINDANE)	31	100	.004	.004
α-CHLORDANE	3	9	L.001	--
γ-CHLORDANE	10	32	L.001	--
o,p-DDT	0	0	L.001	--
p,p-DDT	3	9	L.001	--
p,p-DDE	5	16	L.001	--
p,p-TDE(DDD)	2	6	L.001	--
ENDRIN	0	0	L.001	--
HEPTACHLOR	0	0	L.001	--
HEPTACHLOR EPOXIDE	6	19	L.001	--
HCB	17	54	.001	.001
MIREX	0	0	L.001	--
METHOXYCHLOR	2	6	L.001	--
α-ENDOSULFAN	4	12	L.001	--
β-ENDOSULFAN	0	0	L.001	--

* Data set from Jan 8-Sept 9/80 (31 samples analysed)

Detection limits as zero values in mean calculations

L - less than detection limit

TABLE 5. SUMMARY OF 1979 UPPER NIAGARA RIVER

MEAN TRACE METAL DATA (mg/L)

(WATER)

PARAMETER	RIVER RANGE					
	20.5	26.7	36.0	23.3	31.0	19.5
As-DISS	.0004	.0003	.0004	.0004	.0004	.0004
Se-DISS	.0001(8)	.0001(11)	.0001(11)	.0001(12)	.0001(12)	.0001(12)
Hg-EXT	L.00005(2)	L.00005(3)	L.00005(7)	L.00005(4)	L.00005(3)	L.00005(2)
Cd-T	L.001	L.001	L.001	L.001(1)	L.001(1)	L.001(2)
Cr-T	L.001(9)	L.001(5)	L.001(5)	.001(17)	.001(12)	.001(15)
Cu-T	.002(21)	.003	.003	.004	.002	.002(23)
Fe-T	.316	.294	.410	.428	.403	.448
Pb-T	.001(18)	.001(22)	.001(22)	.002(26)	.001(18)	.002(23)
Mn-T	.006(27)	.006	.006	.010	.009	.012
Ni-T	.002(26)	.002(25)	.003(25)	.003(26)	.003(25)	.002(26)
Zn-T	.002(20)	.003(25)	.006(26)	.009	.004(23)	.008(27)

( ) no. of values at or above detection limit

L - less than detection limit

* one half detection limit values used for mean calculations

TABLE 6.

% OF TRACE METAL VALUES ABOVE IJC OBJECTIVES
IN UPPER NIAGARA RIVER WATER SAMPLES

PARAMETER	1978 IJC OBJECTIVES (mg/L)	% 1975	1979
T-Cd	.0002	2*	2*
T-Cu	.005	2	7
T-Fe	.300	22	24(12)'
T-Pb	.025	0	0
T-Zn	.030	0	1
Hg-EXT	.0002	0	0

* Detection limit of analytical method above IJC objective

' last survey data eliminated

TABLE 7. SUMMARY OF 1979 ORGANIC CONTAMINANTS DATA IN UPPER NIAGARA RIVER WATER SAMPLES.

PARAMETER	DETECTION LIMIT (µg/L)	PERCENTAGE OF TIME DETECTED	1978 IJC OBJECTIVE (µg/L)	PERCENTAGE OF TIME ABOVE IJC OBJECTIVE	MEAN VALUE (µg/L) (detection limits=0
∝-BHC	.001	100	--	-	.007
CYANIDE	1.	90	--	-	.002
ɣ-BHC(LINDANE)	.001	84	.010	0	.001
DIELDRIN	.001	32	.001	0	L.001
PCB	.020	19	--	-	.005
PHENOL	1	9	1	4	L.001
p,p-DDE	.001	6	--	-	L.001
HEXACHLOROBENZENE	.001	3	--	-	L.001
β-ENDOSULFAN	.01	3	--	-	L.001
p,p-DDT	.001	1	.003	0	L.001

Detection Limit values entered as zero for mean calculation

L - less than detection limit

TABLE 8.

SUMMARY OF TRACE ELEMENT CONCENTRATION (μg/g) IN SUSPENDED SEDIMENT AT NIAGARA-ON-THE-LAKE

PARAMETER	1978			1979-80		
	N.OBS.	MEAN	S.D.	N.OBS.	MEAN	S.D.
CADMIUM-EXT	13	2.4	0.8	35	2.4	1.3
LEAD-EXT	13	80.0	28.6	35	58.0	18.9
COBALT-EXT	13	6.6	3.3	35	6.5	2.3
COPPER-EXT	13	46.0	15.1	35	44.0	37.0
ZINC-EXT	13	177.0	44.0	35	163.0	50.0
NICKEL-EXT	13	29.0	16.0	35	24.0	12.0
CHROMIUM-EXT	13	39.0	31.0	35	30.0	12.0

TABLE 9. MEAN CONCENTRATIONS OF ORGANIC CONTAMINANTS (ng/g) IN SUSPENDED SEDIMENT AT NIAGARA-ON-THE-LAKE-1980

PARAMETER	NO. OF SAMPLES	CONFIRMED DETECTIONS		
		NO.	MEAN (ng/g)	ST. DEV.
PCB(TOTAL)	24	24	642	534
ALDRIN	24	0	N.D.	--
DIELDRIN	24	21	4	2
α-BHC	24	18	11	15
γ-BHC(LINDANE)	24	10	2	4
α-CHLORDANE	24	14	1	3
γ-CHLORDANE	24	20	2	2
o,p-DDT	24	8	3	5
p,p-DDT	24	18	13	16
p,p-DDE	24	24	19	10
p,p-TDE(DDD)	24	13	2	2
ENDRIN	24	1	L 1	--
HEPTACHLOR	24	0	N.D.	--
HEPTACHLOR EPOXIDE	24	14	2	3
HCB(packed col)*	24(23)	24(23)	160(51)	535(58)
HCB(CAP.COL)	18	18	83	78
MIREX	24	17	6	7
β-ENDOSULFAN	24	0	L 1	--
METHOXYCHLOR	21	17	10	19
α-ENDOSULFAN	24	1	L 1	--

* One high value eliminated

N.D. Values not detected

Data set from Jan 5 - Aug 19/1980

Detection Limit values entered as zero in mean calculations

L - less than detection limit

TABLE 10.

NON-ROUTINE CONTAMINANTS IDENTIFIED

-JANUARY SAMPLES

I	Chlorinated Hydrocarbons	
	Trichlorobenzenes	1 isomer
	Tetrachlorobenzene	2 isomers
	Pentachlorobenzene	
	Hexachlorobenze	
II	Polyaromatic Hydrocarbons	
	Naphthalene	
	Methyl naphthalenes	2 isomers
	Dimethyl naphthalenes	3 isomers
	Trimethyl naphthalenes	4 isomers
	Tetramethyl -4-propenyl-(E)-naphthalene	
	Phenanthrene	
	Methyl phenanthrenes	2 isomers
	Dimethyl phenanthrenes	2 isomers
	Fluoranthene	
	Pyrene	
	Methyl pyrenes or methyl fluoranthenes	4 isomers
	Chrysene or triphenylene or benzanthracene	
	Benzopyrenes or perylene or benzofluoranthenes	2 isomers
III	Alkyl Benzenes	
	toluene	
	C_2-alkyl benzene	1 isomer

.../(cont)

TABLE 10.(CONT)

	C_3-alkyl benzene	two isomers
	C_4-alkyl benzene	six isomers
IV	Phthalic Acid Esters	
	phthalates 3-4 unidentified	

TABLE 11.

Quantification of Selected Residues

in March-April Suspended Sediment Samples

I	Chlorinated Hydrocarbons (ppm)	
	1,2,4-T_3CB (Trichlorobenzene)	trace
	1,2,4,5-T_4CB (Tetrachlorobenzene)	0.003-0.010
	1,2,3,4-T_4CB ( )	0.019-0.145
	Pentachlorobenzene	0.023-0.115
	Hexachlorobenzene	0.017-0.064
II	Polyaromatic Hydrocarbons (ppm)	
	Naphthalene	0.012-0.510
	Acenaphthylene	0.004-0.016
	Acenaphthene	0.008-0.038
	Fluorene	0.010-0.042
	Anthracene/Phenathrene	0.166-1.58
	Fluoranthene	0.173-0.942
	Pyrene	0.141-0.824
	Chrysene/Benzo(A)anthracene	0.105-1.51
	Benzo fluoranthene(B&K)	0.193-1.08
	Benzo pyrene(A&E)	0.190-1.10
	No quantitation on the alkylated PAH due to lack of standards	
III	Phthalic Acid Esters (ppm)	
	Di-n-butyl	0.07-1.0
	Butyl benzyl	trace
	Bis (2-ethyl hexyl)	5.9-107.0
	Di-n-octyl	0.12-7.0

TABLE 12.

COMPARISON OF VOLATILE MATERIALS IN

NIAGARA RIVER FISH AND SUSPENDED SEDIMENT

IDENTITY	NIAGARA RIVER FISH		NIAGARA RIVER SEDIMENT		
	RETENTION TIME (Relative to HCB)	PEAK AREA (Relative to HCB)	RETENTION TIME (Relative to HCB)	PEAK AREA (Relative to HCB)	RATIO OF AREAS
	0.128	0.007	0.125	0.005	1.4
	0.134	0.012	0.133	0.003	4.0
	0.149	0.008	0.145	0.004	2.0
	0.165	0.011	0.166	0.007	1.6
	0.184	0.114	0.182	0.069	1.7
1,2,4 Trichlorobenzene	0.209	0.104	0.209	0.019	5.5
	0.242	0.008			-
	0.255	0.043	0.255	0.003	14.3
	0.267	0.014			-
	0.287	0.125	0.287	0.005	25.0
	0.309	0.028	0.309	0.004	7.0
	0.318	0.012			-
	0.326	0.016	0.326	0.002	8.0
	0.352	0.014	0.351	0.002	7.0
1245 tetrachlorobenzene	0.359	0.086	0.360	0.020	4.3
	0.389	0.015	0.390	0.002	7.5
1234 tetrachlorobenzene	0.472	0.503	0.471	0.101	5.0
	0.552	0.032	0.552	0.006	5.4
	0.564	0.016	0.565	0.002	8.0
	0.582	0.276	0.582	0.011	25.0
	0.632	0.023	0.632	0.007	3.3
	0.661	0.010			-
Pentachlorobenzene	0.671	0.602	0.671	0.223	2.7
	0.720	0.023			-
	0.855	0.015			-
	0.931	0.053	0.930	0.039	1.4
	0.942	0.012			-
	0.959	0.026			-
	0.982	0.030			-
Hexachlorobenzene	1.000	1.000	1.000	1.000	1.20(ABS

TABLE **13.** SUMMARY OF 1979 ENVIRONMENT ONTARIO (MOE) ANALYTICAL RESULTS FOR PCBs, ORGANOCHLORINE PESTICIDES, CHLOROPHENOXY ACID HERBICIDES AND CHLOROPHENOLS (ppb = µg/kg), ARSENIC AND HEAVY METALS (ppm = µg/g) IN NIAGARA RIVER BOTTOM SEDIMENTS***

PARAMETER	MOE Dredging Guideline	LOWER NIAGARA RIVER STATIONS (NRL-)									UPPER NIAGARA RIVER STATIONS (NRU-)															
		1	2	3	4	5	6	7	8	9	1 (18-1)	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PCBs, total	50	160	130	290	66	-	82	2700	640	490	-	710	27	86	50	380	220	140	310	960	-	520	40	48	120
Aldrin		ND	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin		2	ND	-	ND	-	5	26	10	6	ND	6	ND	ND	ND	2	ND	ND	3	2	ND	ND	ND	ND	ND
α-BHC		ND	9	13	ND	-	ND	110	ND	38	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
β-BHC		ND	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lindane (γ-BHC)		ND	ND	ND	ND	-	ND	ND	ND	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND	ND
α-Chlordane		11	14	50	-	-	ND	293	30	61	ND	2	3	ND	ND	5	ND	3	3	ND	ND	ND	ND	-	ND
γ-Chlordane		6	5	35	ND	-	-	64	ND	70	ND	3	3	ND	ND	1	ND	ND	1	ND	ND	ND	ND	ND	ND
o,p-DDT		ND	ND	ND	ND	-	ND	20	ND	21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p-DDT		ND	ND	ND	ND	-	ND	74	ND	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p-DDE		10	9	6	5	-	4	20	5	36	6	19	2	1	3	6	3	5	3	9	1	7	1	1	2
p,p-DDD		ND	ND	14	ND	-	ND	65	ND	63	ND	5	5	ND	ND	ND	ND	9	5	ND	ND	ND	ND	2	ND
ΣDDT + metabolites		10	9	20	5	-	4	179	5	190	6	24	7	1	3	6	3	14	8	9	1	7	1	3	2
Endrin		ND	ND	-	ND	-	ND	13	5	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor		ND	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hept. epoxide		1	1	3	ND	-	1	36	4	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene		45	28	32	1	-	8	250	47	31	ND	22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex		ND	ND	11	ND	-	4	640	6	23	Tr	12	ND	ND	ND	18	8	4	10	10	ND	15	8	ND	5
Thiodan I		1	1	ND	1	-	1	15	4	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thiodan II		2	1	ND	ND	-	1	15	6	45	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-T		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DB		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silvex		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4-Trichlorophenol		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	62	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol		ND	-	ND	ND	-	ND	ND	ND	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	8	2.5	1.5	2.0	8.2	3.5	4.0	4.2	2.8	3.7	2.7	8.2	4.6	2.4	2.5	14	5.4	7.6	2.4	2.4	4.0	3.4	3.2	3.3	1.9
Cadmium	1	0.72	0.55	0.65	<0.40	0.45	0.88	0.88	0.60	0.72	<0.40	0.60	<0.40	<0.40	<0.40	0.50	<0.40	0.40	0.80	0.88	<0.40	<0.40	<0.40	<0.40	0.50
Chromium	25	15	9.5	20	170	15	25	35	16	27	7.8	34	8	14	7	79	5.8	28	19	24	20	8.2	19	8	11
Copper	25	8.8	7.5	13	32	11	16	28	13	21	5.5	40	3.8	14	9.5	110	10	32	12	20	18	7.8	15	7	9.5
Lead	50	13	6	10	60	6.5	16	33	13	19	6	56	4.5	12	7	200	5	98	13	31	20	10	11	4	11
Mercury	0.3	0.19	0.51	0.22	0.86	0.03	0.34	3.2	0.26	0.96	0.09	0.23	0.08	0.07	0.06	0.67	<0.01	0.65	0.04	0.60	0.10	0.06	0.06	0.20	0.04
Nickel	25	7.2	9.5	7.5	17	11	17	20	15	18	20	25	8.8	8	6	38	10	10	13	10	17	6.5	19	9	6
Zinc	100	63	47	150	170	55	96	140	79	110	32	170	26	67	42	460	50	330	120	200	76	210	75	36	100

ND = Below detection limit.
Tr = Trace.
- = no data available
*** = 3-grab Shipek surface sediment (0 to 3 cm) composite per station.

TABLE 14. PCBs AND ORGANOCHLORINE PESTICIDES ACCUMULATED BY FRESHWATER CLAMS (Elliptio complanatus) AFTER 16 DAY'S EXPOSURE - 1980.

Biomonitoring Location	% Fat	Concentration* in ng/g = ppb wet weight								
		PCBs	Total DDT + Metabolites	Mirex	HCB	α-BHC	α-, γ-Chlordane	Dieldrin	Endrin	Heptachlor epoxide
Lake Erie:										
Thunder Bay, Ont.	1.0±0.2	ND	Tr.	ND	Tr.	5±1	2±3	ND	ND	ND
Upper Niagara River:										
Buffalo River mouth, N.Y.	1.0±0.3	Tr.	Tr.	ND	Tr.	4±1	6±4	Tr.	ND	ND
Chippawa Channel/ Chippawa Ont.	1.3±0.5	23±4	11±6	ND	Tr.	5±0.5	2±1	ND	ND	ND
Welland River, Ont.	0.4±0.1	ND	Tr.	ND	ND	4±1	Tr.	ND	ND	1±2
Tonawanda Channel, Niagara Falls, N.Y.	1.5±0.3	79±8	Tr.	Tr.	4±1	12±3	8±2	6±8	17±15	9±8
Lower Niagara River:										
Queenston, Ont.	0.2±0.1	ND	Tr.	ND	Tr.	Tr.	3±1	ND	ND	1±2
Niagara-on-the-Lake/ Fort George, Ont.	0.4±0.1	95±13	Tr.	ND	Tr.	ND	ND	ND	ND	1±2
Detection Limit		20	5	5	1	1	2	2	4	1

* Values are mean and standard deviation of 3 whole clam soft tissue analyses (shell length - 6.5-7.2 cm).
ND = Not detectable (below detection limit).
Tr = Trace.

TABLE 15. HEAVY METALS AND ARSENIC IN ATTACHED FILAMENTOUS ALGAE (Cladophora sp.) - 1980.

Sampling Location	Concentration*, µg/g = ppm, dry weight								
	Arsenic	Cadmium	Cobalt	Lead	Zinc	Antimony	Chromium	Copper	Mercury
Lake Erie:									
Thunder Bay	10.	0.40	0.70	2.0	32.	0.1	6.0	6.0	0.01
Upper Niagara River:									
Buffalo River, N.Y.	35.	0.98	4.0	41.0	110.	0.5	16.	20.	0.04
Buffalo River mouth, N.Y.	15.	0.95	0.8	9.3	65.	0.2	7.0	8.0	<0.01
Chippawa Channel/near Miller Cr., Ont.	7.6	0.40	2.2	4.8	39.	0.1	12.	9.0	<0.01
Chippawa Channel/Chippawa, Ont.	11.	1.3	3.2	5.8	46.	0.1	14.	15.	<0.01
Tonawanda Channel/ Niagara Falls, N.Y.	10.	1.5	1.2	8.3	130.	0.2	16.	12.	0.02
Lower Niagara River:									
Queenston, Ont.	9.2	0.90	2.6	4.8	49.	0.1	11.	14.	<0.01
Peggy's Eddy/Joseph Davies Park, N.Y.	12.	0.73	1.8	7.0	52.	0.1	13.	12.	<0.01
Niagara-on-the-Lake/Fort George, Ont.	12.	1.1	2.2	7.0	49.	<0.1	6.0	12.	<0.01
Lake Ontario:									
Niagara-on-the-Lake/ Fort Mississauga, Ont.	9.5	0.40	0.6	<2.0	25.	<0.1	8.0	4.0	<0.01

* Analysis of composite of samples taken along 20-30 m of shoreline in each sampling location.

TABLE 16. PCBs AND ORGANOCHLORINE PESTICIDES IN YOUNG-OF-THE-YEAR SPOTTAIL SHINERS - 1980.

Sampling Site	Number of Samples*	Total Length, mm	% Fat	Concentration in ng/g = ppb, whole fish, wet weight						
				PCBs	Total DDT + Metabolites	Mirex	HCB	α,β,γ-BHC	α-,γ-Chlordane	Dieldrin
Lake Erie:										
Thunder Bay, Ont.	7	54±7	1.9±0.7	95±2	24±14	ND	ND	2±1	20±9	Tr.
Upper Niagara River:										
Chippawa Channel/Chippawa, Ont.	5	53±2	1.7±0.4	66±31	13±9	ND	ND	3±1	9±3	6±4
Welland River, Ont.	5	50±4	2.3±0.6	56±14	4±3	ND	ND	1±1	5±2	ND
Tonawanda Channel/Love Canal, N.Y.	10	54±4	2.2±0.5	389±108	18±11	5±4	1±2	33±17	10±3	Tr.
Tonawanda Channel/Little River mouth, N.Y.	5	57±4	3.9±0.5	397±127	39±19	13±4	4±1	26±6	23±8	3±3
Lower Niagara River:										
Queenston, Ont.	7	53±2	3.3±0.3	134±20	11±7	Tr.	1±1	7±2	21±9	Tr.
Peggy's Eddy, Joseph Davies Park, N.Y.	7	58±4	2.8±0.5	233±58	36±17	9±6	9±7	15±7	14±6	6±3
Niagara-on-the-Lake, Ont.	7	56±2	2.1±0.4	266±51	41±9	11±2	4±3	24±6	26±7	5±3
	Detection Limit:			20	5	5	1	1	1	1
	IJC Objective:			100	1000	ND				

* Data indicates mean and standard deviation of number of samples analyzed - each sample is a composite of 10 fish.
ND = Not detectable
Tr = Trace

TABLE 17. PCBs AND ORGANOCHLORINE PESTICIDES CHANGES IN YOUNG-OF-THE-YEAR SPOTTAIL SHINERS SAMPLED AT NIAGARA-ON-THE-LAKE, ONTARIO

Year Sampled	Number of Samples*	Total Length, mm	% Fat	Conc'n in ng/g = ppb, whole fish, wet wt.			Approx. % Decline Since 1975	
				PCB	Total DDT + Metabolites	Mirex	PCB	Total DDT + Metabolites
1975	5	56±4	2.3±0.3	690±195	244±52	NA		
1977	7	51±3	2.5±0.6	654±170	157±38	13±4	5	36
1978	8	51±1	1.9±0.2	320±49	99±49	29±8	54	59
1979	8	50±2	2.4±0.4	153±23	26±9	1±2	78	89
1980	7	56±2	2.1±0.4	266±51	41±9	11±2	61	83
		Detection Limit:		20	5	5		
		IJC Objective:		100	1000	ND		

* Data indicates mean and standard deviation of number of samples analyzed - each sample is a composite of 10 fish.
NA = No data available

TABLE 18. ORGANOCHLORINE CONTAMINANTS IN YOUNG-OF-THE-YEAR SPOTTAIL SHINERS, 1979 & 1980. (concentrations* in ng/g = ppb, wet weight, whole fish).

Parameter	Lower Niagara River				Lake Erie	
	Niagara-on-the-Lake, Ont.		Peggy's Eddy/Joseph Davies Park, N.Y.		Centre Creek, Ont.	
	1979	1980	1979	1980	1979	1980
1,2,3-Trichlorobenzene	-	ND	-	ND-13	-	ND
1,2,4-Trichlorobenzene	7-13	ND	-	ND	ND	ND
1,2,3,4-Tetrachlorobenzene	27-220	ND-8	-	18-30	ND	ND
1,2,3,5-Tetrachlorobenzene	4-31	ND	-	28-43	ND-1	ND
1,2,4,5-Tetrachlorobenzene		ND	-	ND		ND
Pentachlorobenzene	1-20	8-18	-	17-24	2-6	ND
Hexachlorobenzene	11-18	7-11	-	12-16	ND-1	ND
Octachlorostyrene	Tr-5	8-10	-	4-7	ND-2	ND
2,4,5-Trichlorophenol	10-22	-	-	-	ND	-
2,4,6-Trichlorophenol	12-33	-	-	-	10-11	-
Pentachlorophenol	7-28	-	-	-	ND-8	-

* Range of concentrations in two (1979) or three (1980) samples, each composed of 10 fish.
ND = Not detected (below detection limit of ~2 ppb).
Tr = Trace.
- = No data available.

Table 19. CONSUMPTION GUIDELINES FOR SPORTS FISH FROM THE NIAGARA RIVER - 1980.*

	Unlimited Consumption / Consommation sans limites	Limited Consumption / Consommation limitée	Limited Consumption / Consommation limitée	Don't Eat At All / Ne pas manger	Occasional Meals Only / Repas occasionnels seulement	Data Not Available / Données non disponibles
Waterbody / Cours d'eau	Fish size in centimetres (inches) / Longueur du poisson en centimètres (pouces)					
Fish Species / Espèces de poisson	< 15 (6)	15-20 (6-8)	20-25 (8-10)	25-30 (10-12)	30-35 (12-14)	35-45 (14-18)	45-55 (18-22)	55-65 (22-26)	65-75 (26-30)	> 75 (30)
(Upper) Niagara River Rivière (Superieur) Niagara (Miller Creek) (Ruisseau Miller) 4258/7857 (Niagara R.M.) (M.R. de Niagara)										
Smallmouth Bass[2] Achigan à petite bouche[2]	★	★					★	★	★	★
Yellow Perch[2] Perchaude[2]	★				★	★	★	★	★	★
White Sucker[2] Meunier noir[2]	★	★						★	★	★
(Lower) Niagara River Rivière (Bas) Niagara (Queenston) 4310/7903 (Niagara R.M.) (M.R. de Niagara)										
Coho[3] Saumon coho[3]	★	★	★	★	★	★	★			
Yellow Perch[2] Perchaude[2]	★				★	★	★	★	★	★
American Eel[2] Anguille d'Amérique[2]	★	★	★	★	★	★				
White Sucker[2] Meunier noir[2]	★	★	★					★	★	★

Contaminant Identification

The type of laboratory tests carried out on each species listed in the tables can be determined by noting the small number (1,2,3,4,5 or 6) that appears after each species name and then checking this number against the following:

Key to Analysis:

1 - Mercury

2 - Mercury, PCB, mirex and pesticides.

3 - PCB, mirex and pesticides

4 - Mercury, PCB and mirex.

5 - Mercury, other metals, PCB, mirex and pesticides.

6 - Mercury, other metals.

Example:

A species name followed by a 2 has been analysed for mercury, PCB, mirex and pesticides.

The fact that testing for a particular contaminant was carried out does not necessarily mean that the fish will contain this substance.

Fish with less than 0.5 parts per million mercury are identified in the tables of this book by .

Fish containing between 0.5 and 1.0 parts per million, identified by , and fish with 1.0 to 1.5 parts per million, identified by , can be eaten by adults (except women of childbearing age) in restricted amounts as indicated in the consumption guidelines. Fish with mercury levels in excess of 1.5 parts per million, identified by , should not be consumed.

Fish exceeding 2.0 ppm PCB, 0.1 ppm mirex, or 5.0 ppm DDT are identified in the tables of this book by .

*From "Guide to Eating Ontario Sports Fish - 1981, Great Lakes" - Government of Ontario, 1981.

Table 19. CONSUMPTION GUIDELINES FOR SPORTS FISH FROM THE NIAGARA RIVER - 1980.*
Cont'd.

Consumption guidelines

The following guidelines reflect the maximum recommended consumption of fish according to contaminant content and duration of fishing vacation — one-week, two-weeks, three-weeks, and more than three weeks. Fishing holidays should be spaced at least six months apart if the maximum recommended for or has been consumed.

Laboratory analyses are carried out on lean, dorsal muscle tissue and the consumption guidelines are based on this portion of the fish. Persons consuming fish prepared in other ways (eg. whole fish, fish steaks, portions with skin and bone intact, etc.) should be aware that the contaminants PCB, mirex and DDT associate with fatty tissue and may be at higher concentrations in the whole fish, fish steaks, etc. than in the sample tested.

If fish indicated in the tables by a symbol are to be eaten, it is recommended that only boneless, skinless fillets be consumed

Children under 15 and women of childbearing age should eat only .

Short-term Consumption

Fish Category	One-Week	Two-Weeks	Three-Weeks
	No restrictions	No restrictions	No restrictions
	10 meals per wk. 2.3 kg./wk. (5.1 lb./wk.)	5 meals per wk. 1.3 kg./wk. (2.8 lb./wk.)	4 meals per wk. 0.95 kg./wk. (2.1 lb./wk.)
	7 meals per wk. 1.54 kg./wk. (3.4 lb./wk.)	4 meals per wk. 0.86 kg./wk. (1.9 lb./wk.)	3 meals per wk. 0.63 kg./wk. (1.4 lb./wk.)
	None	None	None
	1 or 2 meals/wk. 0.45 kg./wk. (1 lb./wk.)	1 or 2 meals/wk. 0.45 kg./wk. (1 lb./wk.)	1 or 2 meals/wk. 0.45 kg./wk. (1 lb./wk.)

Long-Term Consumption

Fish Category	Meals
	No restrictions
	0.226 kg./wk. 0.5 lb./wk.
	0.136 kg./wk. 0.3 lb./wk.
	None
	1 or 2 meals per month 0.45 kg./mo. (1 lb./mo.)

Applying the guidelines

1. No restrictions are placed on consumption of fish in category according to federal guidelines.
2. Women of childbearing age and children under 15 years of age should eat only fish from category.
3. Fishing holidays should be spaced at least six months apart if the maximum recommended meals for , or has been consumed.
4. Anglers should not take home fish for later consumption unless it is from category.
5. A meal is considered to be approximately eight ounces (230 grams).

*From "Guide to Eating Ontario Sports Fish - 1981, Great Lakes" - Government of Ontario, 1981.

TABLE 20.

ENVIRONMENT ONTARIO

2,3,7,8-TCDD (DIOXIN) LEVELS IN FISH

(ANALYSIS OF FILLET SAMPLES FROM FISH COLLECTED IN 1980)

as of July 17/81

LOCATION	SPECIES	# SAMPLED	# POSITIVE AT THE 10 PPT DETECTION LIMIT	2,3,7,8-TCDD RANGE (PPT)
Upper Niagara River (Miller Cr.)	Yellow Perch	6	0	ND
	White Sucker	1	0	ND
	Smallmouth Bass	1	0	ND
Lower Niagara River (Queenston)	American Eel	5	0	ND
	Walleye	1	0	ND
	Rainbow Trout	1	0	ND
	Northern Pike	1	0	ND
	Muskellunge	1	0	ND
	Yellow Perch	6	0	ND
Lake Ontario at Jordan Harbour	Brown Trout	13	7	ND - 19
	White Bass	6	2	ND - 19
* Lake Ontario at Credit River	Coho Salmon	8	0	ND
Lake Ontario at Hearn Generating Station	Smelt	8	1	ND - 11
Lake Ontario Bluffers Park, Scarborough	Lake Trout	5	3	ND - 19
Lake Ontario Bay of Quinte	Yellow Perch	6	0	ND
	White Perch	6	1	ND - 16
Lake Erie at Port Dover	Rainbow Trout	3	0	ND
Detroit River at Fighting Island	Yellow Perch	3	0	ND
Lake Huron Point Edward	Lake Trout	6	0	ND
Lake Huron at Owen Sound	Rainbow Trout	6	0	ND
Lake Huron at St. Joseph Island	Walleye	6	0	ND
Lake Superior at Thunder Bay	Lake Trout	6	0	ND
Grand River - Canagagigue Cr. upstream of Elmira	Rock Bass	2	0	ND
Canagagigue Cr. downstream of Elmira	White Sucker	4	0	ND
	Rock Bass	1	0	ND
	Brown Bullhead	1	0	ND
TOTAL		113	14	

ND - not detected at the 10 parts per trillion detection limit

* Results of more recent analyses released October 26/81 showed an average level of 19.7 ppt (range: 15-26 ppt) in 9 lake trout from the Port Credit area.

TABLE 21a. CONCENTRATION RANGE (µg/l = ppb) OF PCBs, ORGANOCHLORINE PESTICIDES AND DIOXIN IN RAW WATER AT TREATMENT PLANT INTAKES (a) AND IN UPPER NIAGARA RIVER WATER (b) DURING 1979 AND 1980.

Parameter	1978 IJC Spec. Objective	1978 MOE Aquatic Objective	Niagara-on-the Lake (a)						Niagara Falls (a)						Fort Erie (b) (1)						St. Catharines (a)		
			1979			1980			1979			1980			1979			1980			1980		
			N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range
PCBs	-	0.001	7	1	ND-0.020	13	2	ND-0.032	7	0	ND	12	2	ND-0.030	7	0	ND	12	1	ND-0.030	5	0	ND
Aldrin	0.001	0.001	7	0	ND	12	0	ND	7	0	ND	11	0	ND	7	0	ND	11	0	ND	5	0	ND
Dieldrin			7	1	ND-0.001	12	1	ND-0.005	7	1	ND-0.002	11	1	ND-0.005	7	2	ND-0.004	11	1	ND-0.010	5	0	ND
α-BHC	-	-	7	1	ND-0.003	12	8	ND-0.005	7	1	ND-0.005	11	6	ND-0.005	7	1	ND-0.004	11	6	ND-0.006	5	1	ND-0.006
β-BHC	-	-	7	0	ND	12	0	ND	7	1	ND-0.001	11	1	ND-0.001	7	0	ND	11	2	N -0.004	5	0	ND
Lindane (γ-BHC)	0.010	0.010	7	2	ND-0.002	12	4	ND-0.001	7	2	ND-0.003	11	1	ND-0.005	7	2	ND-0.003	11	1	ND-0.001	5	0	ND
α-Chlordane	0.060	0.060	7	0	ND	12	0	ND	7	0	ND	11	0	ND	7	0	ND	11	0	ND	5	0	ND
γ-Chlordane			7	0	ND	12	1	ND-0.003	7	0	ND	11	1	ND-0.002	7	1	ND-0.001	11	1	ND-0.001	5	0	ND
Σ DDT+Metabolites	0.003	0.003	7	0	ND	12	0	ND	7	1	ND-0.005	11	0	ND	7	2	ND-0.005	11	0	ND	5	0	ND
Endrin	0.002	0.002	7	1	ND-0.003	12	1	ND-0.009	7	0	ND	11	2	ND-0.011	7	0	ND	11	0	ND	5	0	ND
Heptachlor	0.001	0.001	7	0	ND	12	0	ND	7	0	ND	11	0	ND	7	0	ND	11	0	ND	5	0	ND
Heptachlor epoxide			7	1	ND-0.010	12	1	ND-0.008	7	0	ND	11	2	ND-0.002	7	0	ND	11	2	ND-0.014	5	0	ND
Hexachlorobenzene (HCB)	-	-	7	0	ND	12	1	ND-0.005	7	0	ND	11	0	ND	7	0	ND	11	0	ND	5	0	ND
Mirex	< det. limit	0.001	7	0	ND	12	0	ND	7	0	ND	10	0	ND	7	0	ND	10	0	ND	5	0	ND
Thiodan I (α-Endosulphan)	-	0.003	7	1	ND-0.003	12	0	ND	7	1	ND-0.002	11	0	ND	7	0	ND	11	0	ND	5	0	ND
Thiodan II (β-Endosulphan)	-		7	0	ND	12	0	ND	7	0	ND	11	0	ND	7	0	ND	11	0	ND	5	0	ND
Dioxin	-		0	-	-	11	0	ND	0	-	-	12	0	ND	0	-	-	11	0	ND	7	0	ND

N = Number of samples
n = Number of samples with detectable concentration of compound.
ND = Not detected (below detection limit)
- = Not available

(1) Fort Erie sampling locations:
Dec/74 - Oct/80 - Fort Erie boat ramp
Nov/80 - Dec/80 - Niagara Christian College

TABLE 21b. CONCENTRATION RANGE (µg/l = ppb) OF HYDROCARBONS IN RAW WATER AT TREATMENT PLANT INTAKES (a) AND IN UPPER NIAGARA RIVER WATER (b) DURING 1979 AND 1980

Parameter	Niagara-on-the-Lake (a)						Niagara Falls (a)						Fort Erie (b) (2)						St. Catharines (a)		
	1979			1980			1979			1980			1979			1980			1980		
	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range
Alkanes:																					
Hexane	9	3	ND-<0.001	14	6	ND-<0.1	9	3	ND-<0.001	13	6	ND-<0.1	9	1	ND-<0.001	14	3	ND-0.4	8	2	ND-0.1
Pentane	9	0	ND	14	2	ND-<0.1	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Alkenes:																					
Methyl pentene	9	0	ND	14	0	ND	9	1	ND-(+)	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Aliphatics:	9	3	ND-(+)	14	3	ND-(+)	9	4	ND-<0.001	13	3	ND-(+)	9	4	ND-<0.001	14	2	ND-(++)	8	2	ND-(+)
Halogenated aliphatics:																					
Carbon tetrachloride	9	1	ND-<0.001	14	0	ND	9	0	ND	13	0	ND	9	1	ND-0.012	14	0	ND	8	0	ND
Bromoform	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	10	0	ND	8	0	ND
Chloroform	9	5	ND-0.5	14	14	<0.001-2.4	9	3	ND-0.4	13	11	ND-0.6	9	8	ND-0.8	10	8	ND-1.5	8	8	<0.001-4.5
Chlorodibromomethane	9	2	ND-(+)	14	2	ND-0.2	9	1	ND-(+)	13	2	ND-<0.001	9	1	ND-(+)	10	2	ND-0.1	8	2	ND-0.9
Dichlorobromomethane	9	2	ND-0.2	14	2	ND-0.3	9	1	ND-0.1	13	1	ND-0.1	9	0	ND	10	1	ND-0.2	8	5	ND-3.0
Dichloroethane	9	1	ND-<0.001	14	0	ND	9	0	ND	13	0	ND	9	0	ND	10	0	ND	8	0	ND
Trichloroethane (1,1,1-)	9	1	ND-(+)	14	3	ND-0.4	9	1	ND-(+)	13	1	ND-0.2	9	1	ND-(+)	14	2	ND-<0.001	8	0	ND
Trichlorotrifluoroethane	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	1	ND-(+)	14	0	ND	8	0	ND
Dichloropropane	9	1	ND-<0.001	14	0	ND	9	0	ND	13	0	ND	9	0	ND	10	0	ND	8	0	ND
Methylene chloride	9	5	ND-9.0	14	11	ND-2.1	9	6	ND-4.0	13	12	ND-39.5	9	7	ND-3.0	14	12	ND-10.2	8	8	<0.001-1.2
Trichloroethylene	9	5	ND-0.184	14	6	ND-0.1	9	2	ND-0.025	13	0	ND	9	5	ND-7.7	14	1	ND-0.1	8	0	ND
Tetrachloroethylene	9	4	ND-0.1	14	3	ND-0.1	9	1	ND-0.006	13	0	ND	9	4	ND-1.0	14	0	ND	8	0	ND
Aromatics:																					
Benzene	9	4	ND-0.263	14	8	ND-0.6	9	5	ND-0.059	13	9	ND-1.2	9	5	ND-2.2	14	10	ND-0.3	8	6	ND-0.6
Ethyl benzene	9	0	ND	14	0	ND	9	1	ND-0.2	13	0	ND	9	0	ND	14	0	ND	8	1	ND-<0.001
Di-ethyl benzene	9	1	ND-0.059	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Toluene	9	3	ND-0.049	14	5	ND-0.3	9	7	ND-0.3	13	7	ND-0.1	9	4	ND-2.9	13	6	ND-0.1	8	3	ND-0.1
Xylene(s)	9	2	ND-0.03	14	6	ND-0.4	9	1	ND-(+)	13	6	ND-0.2	9	2	ND-0.025	14	5	ND-0.4	8	2	ND-(+)
Styrene	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	4	ND-<1.0	8	0	ND
Halogenated aromatics:																					
Dichlorobenzene	9	0	ND	14	2	ND-<0.1	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Chlorotoluene isomer-1	9	0	ND	14	1	ND-<0.1	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Chlorotoluene isomer-2	9	0	ND	14	1	ND-<0.1	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND
m-Chlorotoluene trifluoride	9	1	ND-(+)	14	9	ND-<0.1	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND

TABLE 21b,cont'd

Parameter	Niagara-on-the-Lake (a)						Niagara Falls (a)						Fort Erie (b) (1)						St. Catharines (a)		
	1979			1980			1979			1980			1979			1980			1980		
	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range
Alcohols:																					
n-Butanol	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	1	ND-(+)
sec-Butanol	9	0	ND	14	3	ND-<0.1	9	0	ND	13	3	ND-<0.1	9	0	ND	14	0	ND	8	0	ND
tert-Butanol	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	3	ND-1.0	8	0	ND
Ethers:																					
Ether	9	1	ND-<0.001	14	0	ND	9	1	ND	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Di-ethyl ether	9	2	ND-(+)	14	0	ND	9	1	ND-(+)	13	1	ND-(+)	9	0	ND	14	1	ND-(+)	8	0	ND
Methyl furan	9	0	ND	14	0	ND	9	0	ND	13	1	ND-(+)	9	0	ND	14	1	ND-(+)	8	0	ND
Aldehydes:																					
Butanal	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	4	ND-<1.0	8	0	ND
Isobutanal	9	0	ND	14	0	ND	9	1	ND-(+)	13	0	ND	9	0	ND	14	0	ND	8	0	ND
Hexanal	9	0	ND	14	6	ND-<0.1	9	0	ND	13	5	ND-<0.1	9	0	ND	14	4	[illegible]-0.5	8	6	ND-0.2
Benzaldehyde	9	0	ND	14	0	ND	9	0	ND	13	1	ND-(+)	9	0	ND	14	4	[illegible]-<1.0	8	1	ND-(+)
Ketones:																					
Hexenone	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	1	[illegible]-<1.0	8	0	ND
Sulphides:																					
Carbon disulphide	9	2	ND-(+)	14	1	ND-(+)	9	1	ND-(+)	13	0	ND	9	1	ND-(+)	14	0	ND	8	0	ND
Diethyldisulphide	9	0	ND	14	0	ND	9	0	ND	13	0	ND	9	0	ND	14	0	ND	8	1	ND-(+)

N = Number of samples
n = Number of samples with detectable concentration of compound.
ND = Not detected (below detection limit which varies with compound, but generally is in the range of 0.2-0.5 ppb)
(+) = Present but not quantitated
(++) = More than one of this group observed

(1) Fort Erie sampling locations:
Dec/74 - Oct/80 - Fort Erie boat ramp
Nov/80 - Dec/80 - Niagara Christian College

TABLE 21c. CONCENTRATION (pCi/l) OF RADIONUCLIDES IN RAW WATER AT TREATMENT PLANT INTAKES (a) AND UPPER NIAGARA RIVER WATER (b) DURING 1979 AND 1980*.

Radionuclide	1978 H&WC (1) Drinking Water Max. Accept. Conc.	1978 MOE Drinking Water Criterion	Niagara-on-the-Lake (a)		Niagara Falls (a)		Fort Erie (b) (2)		St. Catharines (a)
			1979	1980	1979	1980	1979	1980	1980
Gross alpha (α)	-	-	-	<1	-	<1	-	<1	<1
Gross beta (β)	-	1,000	-	3	-	2	-	2	2
Cesium 134	-	-	<30	<15	<30	<15	<30	<15	<15
Cesium 137	1,350	-	<30	<15	<30	<15	<30	<15	<15
Cobalt 60	-	-	<30	<15	<30	<15	<30	<15	<15
Radium 226	27	3	-	0.2	-	0.1	-	0.9	0.2
Strontium 89	-	-	<0.1	<0.3	0.3	<0.3	<0.1	<0.3	<0.3
Strontium 90	270	10	0.7	1.0	0.6	0.7	0.7	1.8	0.3
Tritium	1,080,000	-	-	-	-	-	-	-	-

Values prefixed by "<" are detection limits (Ontario Ministry of Labour)
- = Not available
* = One sample only each year

(1) Health and Welfare Canada "maximum acceptable concentration" values were converted from Becquerels (Bq)/ı to picocuries (pCi)/l using the relationship: 1 Bq/l = 27 pCi/l.

(2) Fort Erie sampling locations, 1979 & 1980: Fort Erie boat ramp.

TABLE 22a. CONCENTRATION RANGE (µg/l = ppb) OF PCBs, ORGANOCHLORINE PESTICIDES AND DIOXIN IN TREATED WATER AT TREATMENT PLANT INTAKES DURING 1979 AND 1980.

Parameter	1978 H&WC (1) Drinking Water Max. Accept. Conc.	Niagara-on-the Lake						Niagara Falls				St. Catharines		
		1979			1980			1979			1980	1980		
		N	n	Range	N	n	Range	N	n	Range	N n Range	N	n	Range
PCBs	-	5	0	ND	9	0	ND	4	0	ND	8 0 ND	5	1	ND-0.020
Aldrin	0.7	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Dieldrin	0.7	5	1	ND-0.002	8	2	ND-0.015	5	0	ND	7 1 ND-0.001	4	0	ND
∝-BHC	-	5	0	ND	8	3	ND-0.006	5	1	ND-0.001	7 3 ND-0.005	4	1	ND-0.005
ß-BHC	-	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Lindane (ɣ-BHC)	4	5	0	ND	8	3	ND-0.001	5	0	ND	7 1 ND-0.001	4	0	ND
∝-Chlordane	7	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
ɣ-Chlordane	7	5	0	ND	8	0	ND	5	0	ND	7 1 ND-0.001	4	0	ND
Σ DDT+Metabolites	30	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Endrin	0.2	5	0	ND	8	1	ND-0.005	5	0	ND	7 1 ND-0.020	4	0	ND
Heptachlor	3	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Heptachlor epoxide	3	5	1	ND-0.001	8	0	ND	5	0	ND	7 1 ND-0.001	4	0	ND
Hexachlorobenzene (HCB)	-	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Mirex	-	5	0	ND	7	0	ND	4	0	ND	6 0 ND	4	0	ND
Thiodan I (∝-Endosulphan)	-	5	1	ND-0.004	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Thiodan II (ß-Endosulphan)	-	5	0	ND	8	0	ND	5	0	ND	7 0 ND	4	0	ND
Dioxin	-	0	-	-	9	0	ND	0	-	-	10 0 ND	5	0	ND

N = Number of samples.
n = Number of samples with detectable concentration of compound.
ND = Not detected (below detection limit).
- = Not available.

(1) 1978 Health and Welfare Canada maximum acceptable concentrations in drinking water.
(2) Fort Erie sampling locations:
Dec/74 - Oct/80 - Fort Erie boat ramp
Nov/80 - Dec/80 - Niagara Christian College

TABLE 22b. CONCENTRATION RANGE (µg/l = ppb) OF HYDROCARBONS IN TREATED WATER AT TREATMENT PLANT INTAKES DURING 1979 AND 1980.

Parameter	1978 H&WC (1) Drinking Water Max. Accept. Conc.	Niagara-on-the-Lake						Niagara Falls				St. Catharines		
		1979			1980			1979			1980	1980		
		N	n	Range	N	n	Range	N	n	Range	N n Range	N	n	Range
Alkanes:														
Hexane		5	0	ND	11	3	ND-≈0.2	5	0	ND	11 3 ND-≈0.3	7	2	ND-≈0.1
Pentane(s)		5	0	ND	11	2	ND-≈0.5	5	0	ND	11 1 ND-≈0.3	7	2	ND-≈0.5
Alkenes:														
Methyl pentene		5	0	ND	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Aliphatics:		5	3	ND-(+)	11	2	ND-(++)	5	3	ND-(+)	11 1 ND-(++)	7	2	ND-(++)
Halogenated aliphatics:														
Carbon tetrachloride		5	0	ND	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Bromoform		5	4	ND-0.889	11	10	ND-0.4	5	4	ND-0.600	11 11 0.2-0.7	7	7	0.3-0.7
Chloroform	350	5	5	8.0-20.0	11	11	4.1-9.1	5	5	10.6-18.0	11 11 2.0-7.6	7	7	2.9-10.0
Chlorodibromomethane		5	5	<0.001-(+)	11	11	1.7-5.2	5	5	<0.001-(+)	11 11 1.7-6.1	7	7	2.5-5.6
Dichlorobromomethane		5	5	(+)-20.0	11	11	3.6-13.5	5	5	(+)-8.3	11 11 3.0-11.3	7	7	4.7-18.1
Dichloroiodomethane		5	0	ND	11	2	ND-(+)	5	0	ND	11 3 ND-<0.001	7	3	ND-<0.001
Dichloroethane		5	0	ND	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Trichloroethane (1,1,1-)		5	1	ND-(+)	11	2	ND-<0.001	5	0	ND	11 2 ND-0.4	7	1	ND-<0.001
Trichlorotrifluoroethane		5	0	ND	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Dichloropropane		5	0	ND	11	0	ND	5	0	ND	11 0 ND	7	1	ND-0.1
Methylene chloride		5	5	0.147-0.400	11	10	ND-3.0	5	5	0.200-4.0	11 10 ND-10.9	7	6	ND-1.5
Trichloroethylene		5	5	<0.001-0.231	11	5	ND-0.1	5	2	ND-0.031	11 0 ND	7	0	ND
Tetrachloroethylene		5	4	ND-0.340	11	0	ND	5	1	ND-0.012	11 1 ND-<0.001	7	0	ND
Aromatics:														
Benzene		5	3	ND-0.324	11	8	ND-1.9	5	3	ND-0.457	11 8 ND-1.8	7	6	ND-0.4
Ethyl benzene		5	2	ND-0.062	11	0	ND	5	3	ND-0.100	11 0 ND	7	0	ND
Di-ethyl benzene		5	0	ND	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Cumene		5	1	ND-0.061	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Toluene		5	5	0.100-1.9	11	11	<0.001-0.8	5	5	0.070-0.900	11 7 ND-0.5	7	5	ND-0.5
Ethyl toluene		5	1	ND-0.105	11	0	ND	5	0	ND	11 0 ND	7	0	ND
Xylene(s)		5	3	ND-0.182	11	5	ND-0.2	5	1	ND-(+)	11 6 ND-0.3	7	3	ND-0.1
Styrene		5	0	ND	11	0	ND	5	0	ND	11 1 ND-(+)	7	0	ND

TABLE 22b. cont'd

Parameter	1978 H&WC (1) Drinking Water Max. Accept. Conc.	Niagara-on-the-Lake 1979 N	n	Range	Niagara-on-the-Lake 1980 N	n	Range	Niagara Falls 1979 N	n	Range	Niagara Falls 1980 N	n	Range	St. Catharines 1980 N	n	Range
Halogenated aromatics:																
Chlorobenzene		5	2	ND-0.021	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Dichlorobenzene		5	0	ND	11	1	ND-<0.001	5	0	ND	11	0	ND	7	0	ND
Chlorotoluene isomer-1		5	0	ND	11	2	ND-<0.001	5	0	ND	11	0	ND	7	0	ND
Chlorotoluene isomer-2		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
m-Chlorotoluene trifluoride		5	2	ND-(+)	11	6	ND-~0.1	5	0	ND	11	0	ND	7	0	ND
Alcohols:																
n-Butanol		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
sec-Butanol		5	0	ND	11	1	ND-<0.001	5	0	ND	11	0	ND	7	0	ND
tert-Butanol		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Ethers:																
Ether		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Di-ethyl ether		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Methyl furan		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Aldehydes:																
Butanal		5	0	ND	11	1	ND-~0.1	5	0	ND	11	0	ND	7	0	ND
Isobutanal		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Hexanal		5	0	ND	11	4	ND-~0.4	5	0	ND	11	5	ND-~0.4	7	4	ND-~0.4
Benzaldehyde		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	1	ND-(+)
Ketones:																
Hexenone		5	0	ND	11	0	ND	5	0	ND	11	0	ND	7	0	ND
Sulphides:																
Carbon disulphide		5	1	ND-(+)	11	2	ND-~0.1	5	1	ND-(+)	11	0	ND	7	0	ND
Diethyldisulphide		5	0	ND	11	0	N	5	0	ND	11	0	ND	7	0	ND

N = Number of samples.
n = Number of samples with detectable concentration of compound.
ND = Not detected (below detection limit which varies with compound, but generally is in the range of 0.2-0.5 ppb).
(+) = Present but not quantitated.
(++) = More than one of this group observed.
~ = Approximate concentration
< = Actual concentration is less than this value.

(1) Health and Welfare Canada maximum acceptable concentrations in drinking water.
(2) Fort Erie sampling locations:
Dec/74 - Oct/80 - Fort Erie boat ramp
Nov/80 - Dec/80 - Niagara Christian College

TABLE 23. COMPARISON OF CONCENTRATION OF SOME TRACE ORGANICS DETECTED IN TREATED WATER AT MUNICIPAL INTAKES WITH SUGGESTED DRINKING WATER LIMITS.

Parameter	Suggested Drinking Water Limits (µg/l = ppb)	Concentration Range, 1979 & 1980 (µg/l = ppb)		
		Niagara-on-the-Lake	Niagara Falls	St. Catharines (1980 only)
α-BHC	0.016(c)	ND-0.006	ND-0.005	ND-0.005
β-BHC	0.028(c)	ND	ND	ND
Endosulphan (Thiodan)	100(c)	ND-0.004	ND	ND
Carbon tetrachloride	3(a), 2.6(c), 300(d)	ND	ND	ND
Dichloroethane	10(a)	ND	ND	ND
Trichloroethane	3800(b)	ND-<0.001	ND-0.4	ND-<0.001
Methylene chloride	2(c)	ND-3.0 (1/16)*	ND-10.9 (4/16)*	ND-1.5
Trichloroethylene	30(a), 21(c)	ND-0.231	ND-0.031	ND
Tetrachloroethylene	10(a), 2(c)	ND-0.340	ND-0.012	ND
Benzene	10(a), 107(c), 15(c), 100(d)	ND-1.9	ND-1.8	ND-0.4
Toluene	340(b), 100(d)	<0.001-1.9	ND-0.9	ND-0.5
Chlorobenzene	450(c), 20(d)	ND-0.021	ND	ND
Di-ethyl ether	300(d)	ND	ND	ND

Sources of Information:

(a) - World Health Organization - proposed maximum acceptable concentration.

(b) - National Academy of Science - drinking water and health suggested no adverse response level.

(c) - Sitting, M. (ed.)(1980). Priority toxic pollutants - health impacts and allowable limits. Noyes Data Compl., Park Ridge, New Jersey.

Note: underlined values=daily dose level for long-term exposure with cancer prevention as the goal (less than 10^{-5} chance of tumour development over human life span).

(d) - Verschueren, K. (1977). Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co. N.Y.

* - Indicates number of

TABLE 24. CRITERIA FOR EPA PRIORITY POLLUTANTS IN WATER.

Notes

1. The criteria are the best possible estimates at the present time. Frequently they are not obtained according to the guidelines but inferred from other data. Refer to the literature for the precise information.
2. Criteria for human health which are ranked with (c), indicates that the compound is a carcinogen, and the criteria are accompanied by a lifetime risk of cancer of 10^{-5}.
3. Criteria for human health when marked with (t), are based on the organoleptic properties of the compound in water.
4. Criteria for human health when unlabelled, are based on toxic properties or adverse effects to human health.
5. Criteria labelled ND indicates no data available.
6. If a compound bioaccumulates then the criteria for human health are determined by exposure to water and an average consumption of fish products.

Compound	Aquatic Life Criteria for Freshwater 24 hr. Avg.	Max. at any one time	Criteria for Human Health Under Consideration	Office of Water Planning and Standards (EPA) Microfiche No.
Acenaphthalene	110 ug/l	240 ug/l	0.02mg/l(t)	PB296732
Acrolein	1.2 ug/l	2.7 ug/l	6.5 ug/l	PB296738
Acrylonitrile	130 ug/l	300 ug/l	0.06 ug/l (c)	PB297915
Benzene	3,100 ug/l	7,000 ug/l	13.0 ug/l (c)	PB292621
Benzidine	ND	ND	1.67×10^{-3} ug/l (c)	PB297918
Chloroform	300 ug/l	1,700 ug/l	2.1 ug/l (c)	PB292627
Carbontetrachloride	620 ug/l	1,400 ug/l	2.6 ug/l (c)	PB292624
Chlorinated Alkyl Ethers				
Bis(2)chloroethyl ether	ND	ND	0.42 ug/l (c)	PB297921
Bis(2)chloroisopropyl ether	ND	ND	11.3 ug/l (c)	PB297921
Bis(chloromethyl)ether	ND	ND	2.0×10^{-3} ug/l (c)	PB297921
Chlorobenzenes				
Chlorobenzene	1300 ug/l	3,300 ug/l	20.0 ug/l (t)	PB297919
1,2,4-Trichlorobenzene	210 ug/l	475 ug/l	13.0 ug/l (t)	PB297919
1,2,3,5-Tetrachlorobenzene	170 ug/l	390 ug/l	17.0 ug/l	PB297919
1,2,4,5-Tetrachlorobenzene	97 ug/l	220 ug/l	17.0 ug/l	PB297919
Hexachlorobenzene	ND	ND	1.25 ug/l (c)	PB297919
Pentachlorobenzene	16 ug/l	36 ug/l	0.5 ug/l	PB297919
Chlorinated Ethanes				
1,2-Dichloroethane	3,900 ug/l	8,800 ug/l	7.0 ug/l (c)	PB297920
Pentachloroethane	440 ug/l	1,000 ug/l	ND	PB297920
1,1,2,2-Tetrachloroethane	170 ug/l	380 ug/l	1.3 ug/l (c)	PB297920
1,1,2-Trichloroethane	310 ug/l	710 ug/l	2.7 ug/l (c)	PB297920
1,1,1-Trichloroethane	3,300 ug/l	12,000 ug/l	15.7 mg/l	PB297920
Chlorinated Ethylenes				
1,2-Dichloroethylene	620 ug/l	1,400 ug/l	ND	PB292630
1,1-Dichloroethylene	950 ug/l	1,300 ug/l	ND	PB292630
Tetrachloroethylene	310 ug/l	700 ug/l	3.0 ug/l (c)	PB292643
Trichloroethylene	1,300 ug/l	3,400 ug/l	21.0 ug/l (c)	PB292643
Chloronaphthalenes				
1-Chloronaphthalene	29 ug/l	67 ug/l	3.9 ug/l	PB292636
Tetrachloronaphthalene	ND	ND	1.5 ug/l	PB292636
Pentachloronaphthalene	ND	ND	0.39 ug/l	PB292636
Hexachloronaphthalene	ND	ND	0.15 ug/l	PB292636
Octachloronaphthalene	ND	ND	0.08 ug/l	PB292636
Chlorophenols				
2-Chlorophenol	60 ug/l	180 ug/l	5.3 ug/l (t)	PB292628
3-Chlorophenol	ND	ND	30.0 ug/l (t)	PB296790
4-Chlorophenol	45 ug/l	180 ug/l	30.0 ug/l (t)	PB296790
2,4-Dichlorophenol	0.4 ug/l	110 ug/l	0.3 ug/l (t)	PB292631
2,3-Dichlorophenol	ND	ND	3.0 ug/l (t)	PB296790
2,6-Dichlorophenol	ND	ND	3.0 ug/l (t)	PB296790
Pentachlorophenol	4.2 ug/l	14.0 ug/l	140 ug/l	PB292639
2,4,5-Trichlorophenol	ND	ND	30.0 ug/l (t)	PB296790
2,3,4-Trichlorophenol	32 ug/l	130 ug/l	100 ug/l (t)	PB296790
2,3,4,6-Tetrachlorophenol	ND	ND	263 ug/l	PB296790

FROM: G.S. Hendry (1981). Priority Pollutants Status Report
OTC Rept:8103; Project:GH8101
Ontario Ministry of the Environment, 76 pp.

TABLE 24. CONT'D

Compound	Aquatic Life Criteria for Freshwater 24 hr. Avg.	Aquatic Life Criteria for Freshwater Max. at any one time	Criteria for Human Health Under Consideration	Office of Water Planning and Standards (EPA) Microfiche No.
Dichlorobenzenes				
1,2-Dichlorobenzene	44 ug/l	99 ug/l	230 ug/l	PB292429
1,3-Dichlorobenzene	320 ug/l	700 ug/l	230 ug/l	PB292429
1,4-Dichlorobenzene	190 ug/l	44 ug/l	230 ug/l	PB292429
Dichlorobenzidine	ND	ND	1.69×10^{-2} ug/l (c)	PB296793
Dichloropropanes/enes				
1,1-Dichloropropane	610 ug/l	930 ug/l	203 ug/l	PB296799
1,2-Dichloropropane	930 ug/l	2,100 ug/l	203 ug/l	PB296799
1,3-Dichloropropane	4,800 ug/l	11,000 ug/l	203 ug/l	PB296799
1,3-Dichloropropene	18 ug/l	290 ug/l	0.63 ug/l	PB296799
2,4-Dimethylphenol	38 ug/l	86 ug/l	ND	PB292432
Dinitrotoluenes				
2,4-Dinitrotoluene	630 ug/l	1,400 ug/l	740 ug/l (c)	PB296794
2,3-Dinitrotoluene	12 ug/l	27 ug/l	ND	PB296794
1,2-Diphenylhydrazine	17 ug/l	38 ug/l	0.4 ug/l (c)	PB296793
Ethyl Benzene	ND	ND	1.1 mg/l	PB296784
Fluoranthene	250 ug/l	560 ug/l	200 ug/l	PB292433
Haloethers				
4-Bromophenylphenylether	6.2 ug/l	14.0 ug/l	ND	PB296796
Halomethanes				
Chloromethane	7,000 ug/l	16,000 ug/l	2.0 ug/l	PB296797
Bromodichloromethane	ND	ND	2.0 ug/l	PB296797
Bromomethane	140 ug/l	320 ug/l	2.0 ug/l	PB296797
Dichlorodifluoromethane	ND	ND	3,000 ug/l	PB296797
Dichloromethane	4,000 ug/l	9,000 ug/l	2.0 ug/l	PB296797
Tribromomethane	840 ug/l	1,900 ug/l	2.0 ug/l	PB296797
Trichlorofluoromethane	ND	ND	32,000 ug/l	PB296797
Hexachloroethane	62 ug/l	140 ug/l	3.9 ug/l (c)	PB297920
Hexachlorobutadiene	ND	ND	0.77 ug/l (c)	PB292435
Hexachlorocyclopentadiene	0.39 ug/l	7.0 ug/l	1.0 ug/l (t)	PB292436
Isophorone	2,100 ug/l	4,700 ug/l	460 ug/l	PB296798
Naphthalene	ND	ND	143 ug/l	PB296786
Nitrobenzene	480 ug/l	1,100 ug/l	30 ug/l (t)	PB296801
Nitrosamines	ND	ND	0.036 ug/l (c)	PB292438
Nitrophenols				
2-Nitrophenol	2,700 ug/l	6,200 ug/l	ND	PB296802
4-Nitrophenols	240 ug/l	550 ug/l	ND	PB296802
2,4-Dinitrophenol	79 ug/l	180 ug/l	68.6 ug/l	PB296802
2,4,6-Trinitrophenol	1,500 ug/l	3,400 ug/l	15.0 ug/l	PB296802
2,4-Dinitro-6-methylphenol	57 ug/l	130 ug/l	12.8 ug/l	PB296802
Polynuclear Aromatic Hydrocarbons (as a class)	ND	ND	9.7×10^{-3} ug/l (c)	PB292434
Polychlorinated Biphenyls (as a class)	0.0013 ug/l	6.2 ug/l	2.6×10^{-4} ug/l (c)	PB296803
Phenol	600 ug/l	3,400 ug/l	1.0 ug/l (t)	PB296787
Phthalate Esters				
Diethylphthalate	ND	ND	60 mg/l	PB296804
Dimethylphthalate	ND	ND	160 mg/l	PB296804
Dibutylphthalate	ND	ND	3 mg/l	PB296804
Di(2ethylhexyl)phthalate	ND	ND	10 mg/l	PB296804
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	ND	ND	4.33×10^{-7} ug/l (c)	PB292442
Toluene	2,300 ug/l	5,300 ug/l	13.4 mg/l	PB296803
Vinyl Chloride	ND	ND	517 ug/l (c)	PB292446

FROM: G.S. Hendry (1981). Priority Pollutants Status Report OTC Rept:8103; Project:GH8101 Ontario Ministry of the Environment, 76 pp.

TABLE 25. ONTARIO MUNICIPAL & INDUSTRIAL TRACE CONTAMINANT LOADINGS (Kg/day) (1) TO THE NIAGARA RIVER AND ITS TRIBUTARIES.

Parameter	Municipal Direct	Industrial Direct	Municipal Indirect	Industrial Indirect	Total, Munic. & Industrial
Aluminum	3.616	60.118	285.112	423.793	772.639
Arsenic	<0.113	< 0.080	< 1.212	< 0.935	< 2.340
Cadmium	0.045	< 0.024	0.239	< 0.306	0.614
Calcium	-	261.573	-	4890.161	∿5151.734
Chromium	0.068	< 0.080	2.666	< 23.612	< 26.426
Cyanide	0.113	< 0.158	< 1.212	< 1.416	< 2.899
Copper	0.158	< 0.126	2.818	< 1.271	< 4.373
Iron	45.200	5.137	664.531	413.007	1127.875
Lead	ND	< 0.950	ND	< 4.793	< 5.743
Magnesium	-	62.191	-	1049.853	∿1112.044
Manganese	-	0.121	-	10.039	∿10.160
Mercury	0.0007	< 0.0003	0.026	< 0.011	< 0.038
Molybdenum	-	< 0.119	-	< 3.483	< 3.602
Nickel	0.124	< 0.238	4.333	< 10.048	< 14.743
Zinc	1.808	< 0.218	11.175	< 3.418	< 16.619
Phenols	0.158	∿0.008	1.099	< 0.078	< 1.343
2,4,6-Trichlorophenol	0.0001	ND	ND	ND	0.0001
Pentachlorophenol	0.014	ND	ND	0.005	0.019
PCBs, total	ND	ND	0.0048	0.00007	0.00487
Dieldrin	0.00002	ND	-	ND	0.00002
α-BHC	0.00003	0.00002	-	0.0008	0.00085
β-BHC	0.00001	ND	-	ND	0.00001
Lindane (γ-BHC)	ND	ND	-	0.0021	0.00210
Hexachlorobenzene	0.00001	ND	0.0016	0.00007	0.00168
Carbon tetrachloride	ND	ND	ND	ND	ND
Bromoform	ND	0.000006	ND	0.00013	0.0001
Chloroform	0.010	< 0.0009	0.191	0.250	< 0.452
Chlorodibromomethane	ND	0.00009	ND	< 0.008	< 0.008
Dichlorobromomethane	ND	0.0002	ND	< 0.028	< 0.028
1,1-Dichloroethane	ND	0.0003	0.010	0.003	0.013
1,2-Dichloroethane	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.009	0.0016	0.083	0.068	0.162
1.S. 1,3-Dichlorobutane	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	0.0006	0.0006
Methylene chloride	0.133	0.008	2.102	3.736	5.979
Trichloroethylene	0.001	0.0007	0.811	∿1.100	∿1.913
Tetrachloroethylene	0.025	0.000006	0.430	< 0.006	< 0.461
Benzene	0.018	0.0001	0.356	0.209	0.583
Ethylbenzene	0.057	0.000006	0.056	< 0.004	< 0.117
Toluene	∿0.103	0.00002	0.338	< 0.044	< 0.485
m-Xylene	0.097	< 0.00008	0.190	< 0.014	< 0.301
o- or p-Xylene	0.090	0.000006	0.141	< 0.008	< 0.239
Chlorobenzene	< 0.001	ND	< 0.004	0.002	< 0.007

(1) Results of preliminary survey conducted January 26 - February 24, 1981.
-each effluent sample a 3-part grab composite for 1 day.

ND = Not detected (below detection limit).

- = No data available.

∿ = Loading value is approximate due to difficulties in analytical quantification of effluent sample(s).

< = Loading value is less than that reported due to only trace concentrations being detected in some effluent samples - these were assigned a value equivalent to detection limit for calculation purposes.

TABLE 26. NIAGARA FALLS, N.Y. WASTEWATER TREATMENT PLANT TRACE CONTAMINANTS LOADS.*
(kg/day)

Parameter	
Aluminum	78.599
Arsenic	< 2.267
Cadmium	< 0.453
Chromium	3.023
Cobalt	< 2.267
Copper	13.604
Cyanide, total	9.825
Iron	92.958
Lead	6.802
Mercury	< 0.045
Nickel	7.558
Selenium	< 2.267
Tin	1.512
Zinc	8.313
Phenols	103.539
Acetone	< 0.227
Carbon tetrachloride	3.552
Bromoform	ND
Chloroform	6.122
Chlorodibromomethane	ND
or 1,1,2-Trichloroethane	
Dichlorobromomethane	ND
Dichloromethane	7.709
1,2-Dichloroethane	ND
1,1,1-Trichloroethane	0.680
Trichlorofluoromethane	0.227
or 1,1-Dichloroethylene	
Trans-1,2-Dichloroethylene	8.389
Trichloroethylene	9.145
Tetrachloroethylene or	6.726
1,1,2,2-Tetrachloroethane	
Trans-1,3-Dichloropropene	0.453
Benzene or	6.651
Cis-1,3-Dichloropropene	
Ethyl benzene	0.302
Toluene	3.325
Chlorobenzene	2.494
Tetrahydrofuran	415.668

ND = Not detected (below detection limit)

* = Based on Environment Canada sampling and analysis of effluent prior to chlorination (24 hr. composites, May 5-7/81). Loadings calculated assuming discharge flow of 226.73 x $10^3 m^3$/day (49.9 x 10^6 Imperial gal./day).

< = Loading value is less than that reported due to only trace concentrations being detected in some effluent samples - these were assigned a value equivalent to detection limit for calculation purposes.

TABLE 27. HOOKER CHEMICALS AND PLASTICS CORP./NIAGARA FALLS PLANT.

TRACE CONTAMINANT LOADS
1979 Average
(kg/day)

Trichloroethylene	6.7
Tetrachloroethylene	3.7
Toluene	3.3
Chlorobenzotrifluorides	19.2
Monochlorobenzene	1.2
Dichlorobenzene	1.7
Chlorotoluenes	23.9
Dichlorotoluenes	1.6
Trichlorobenzenes	2.5
Tetrachlorobenzenes	3.2
Hexachlorocyclopentadiene	1.1

Adapted From: The Ravaged River. Toxic Chemicals in the Niagara. The New York Public Interest Research Group, Inc., 1981.

TABLE 28. Comparison of Total Ontario Point-Source and Niagara Falls, N.Y. Wastewater Treatment Plant Inputs to the Niagara River with River Loads Derived from Ambient Monitoring at Fort Erie and Niagara-on-the-Lake.

Parameter	Fort Erie (1)		Niagara-on-the-Lake (2)		Total Ontario Municipal & Industrial Loading (3)		Niagara Falls, N.Y. Wastewater Treatment Plant Loading (4)	
	mean 1980 concentration µg/l	mean 1980 load kg/day	mean 1980 concentration µg/l	mean 1980 load kg/day	kg/day	% of Niagara-on-the-Lake	kg/day	% of Niagara-on-the-Lake
Aluminum	-	-	164.091	~1128.822	772.639	0.95	78.599	0.10
Arsenic	-	-	0.776	383.418	<2.340	<0.61	<2.267	<0.59
Cadmium	-	-	0.107	52.734	0.614	1.16	<0.453	<0.86
Chromium	-	-	12.292	6077.332	<26.426	<0.44	3.023	0.05
Cyanide	-	-	* 5 (<10)	2472.068	<2.899	<0.12	9.825	≥0.40
Copper	-	-	1.867	923.070	<4.373	<0.47	13.604	1.47
Iron	-	-	165.104	81629.663	1127.875	1.38	92.958	0.11
Lead	-	-	1.600	791.062	<5.743	<0.73	6.802	0.86
Mercury	-	-	0.103	50.925	<0.038	<0.07	<0.045	<0.09
Nickel	-	-	*10 (<20)	4944.136	<14.743	<0.30	7.558	≥0.15
Zinc	-	-	* 5 (<10)	2472.068	<16.619	<0.67	8.313	≥0.34
Phenols	*0.5 (<1)	248.186	0.625	309.008	<1.343	<0.43	103.539	33.5
PCBs, total	0.0 (ND)	0.0	0.005	2.472	0.00487	0.20	-	-
Dieldrin	0.00143	0.710	0.00061	0.020	0.00002	0.10	-	-
∝-BHC	0.00200	0.993	0.0029	1.433	0.00085	0.06	-	-
Lindane (γ-BHC)	0.000143	0.071	0.0003	0.148	0.00210	1.42	-	-
Hexachlorobenzene	0.0 (ND)	0.0	0.0004	0.198	0.00168	0.04	-	-
Chloroform	0.290	143.948	0.376	186.890	<0.452	<0.24	6.122	3.28
Chlorodibromomethane	0.020	9.927	0.027	13.349	<0.008	<0.06	0.0 (ND)	0.0
Dichlorobromomethane	0.020	9.927	0.029	14.338	<0.028	<0.20	0.0 (ND)	0.0
1,1,1-Trichloroethane	0.0 (ND)	0.0	0.033	16.316	0.162	0.99	0.680	4.17
Methylene chloride	0.440	218.404	0.636	314.446	5.979	1.90		
Trichloroethylene	0.010	4.964	0.013	6.427	~1.913	~29.76	9.145	142.00
Tetrachloroethylene	0.0 (ND)	0.0	0.007	3.461	<0.461	<13.32	6.726	194.00
Benzene	0.180	89.347	0.220	108.771	0.503	0.54	6.651	6.11
Toluene	0.022	11.030	0.057	28.182	<0.485	<1.72	3.325	11.80
m-Xylene	~0.00005	~0.025	0.029	14.338	<0.301	<2.10	-	-
o- or p-Xylene	~0.00005	~0.025	0.013	6.427	<0.239	<3.72	-	-

ND = Not detected (below detection limit).

- = No data available.

~ = Loading value is approximate due to difficulties in analytical quantification of effluent sample(s).

< = Loading value is less than that reported due to only trace concentrations being detected in some effluent samples - these were assigned a value equivalent to detection limit for calculation purposes.

* = All samples below detection limit (indicated in brackets) - assigned half of detection limit for calculation purposes.

(1) PCBs, organochlorine pesticides and volatile organics loads obtained from Environment Ontario analyses of raw (river) water samples taken at Fort Erie boat ramp (Jan.-Oct./80). Phenols load derived from surface water samples taken during 1980 along Range 37.7. Loadings based on river flow of 202,800 ft^3/sec.

(2) PCBs, organochlorine pesticides and volatile organics loads obtained from Environment Ontario analyses of raw water samples taken at Niagara-on-the-Lake water treatment plant intake (Jan.-Dec./80). Metals and phenols loads derived from surface water samples taken during 1980 along Range 1.3. Loadings based on river flow of 202,000 ft^3/sec.

(3) Based on Environment Ontario municipal and industrial outfalls survey (Jan.26-Feb.24/81).

(4) Based on Environment Canada sampling and analysis of effluent prior to chlorination (24 hr. composites, May 5-7/81). Loadings calculated assuming discharge flow of 226.73 x $10^3 m^3$/day (49.9 x 10^6 Imperial gal./day).